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PHASE II - COMPREHENSIVE SITE
ASSESSMENT
60 OLYMPIA AVENUE
WOBURN, MASSACHUSETTS
DEP CASE NO. 3-594
VOLUME II OF II

**PHASE II - COMPREHENSIVE SITE
ASSESSMENT
60 OLYMPIA AVENUE
WOBURN, MASSACHUSETTS
DEP CASE NO. 3-594
VOLUME II OF II**

PREPARED FOR:
Juniper Development
Winchester, Massachusetts

PREPARED BY:
GZA GeoEnvironmental, Inc.
Newton Upper Falls, Massachusetts

December 1991
File No. 4596.2

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APPENDIX A
LIMITATIONS

GEOHYDROLOGICAL LIMITATIONS

1. The conclusions and recommendations submitted in this report are based in part upon the data obtained from a limited number of soil samples from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until further investigation. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the recommendations of this report.
2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the boring logs.
3. Water level readings have been made in the test pits, borings and/or observation wells at times and under conditions stated on the exploration logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall and other factors different from those prevailing at the time measurements were made.
4. Except as noted within the text of the report, no quantitative laboratory testing was performed as part of the site assessment. Where such analyses have been conducted by an outside laboratory, GZA GeoEnvironmental, Inc. (GZA) has relied upon the data provided, and has not conducted an independent evaluation of the reliability of these data.
5. The conclusions and recommendations contained in this report are based in part upon various types of chemical data and are contingent upon their validity. These data have been reviewed and interpretations made in the report. As indicated within the report, some of these data are preliminary "screening" level data, and should be confirmed with quantitative analyses if more specific information is necessary. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their flow paths may occur due to seasonal water table fluctuations, past disposal practices, the passage of time, and other factors. Should additional chemical data become available in the future, these data should be reviewed by GZA, and the conclusions and recommendations presented therein modified accordingly.
6. Chemical analyses have been performed for specific parameters during the course of this study, as detailed in the text. It must be noted that additional constituents not searched for during the current study may be present in soil and groundwater at the site.
7. It is recommended that this firm be retained to provide further engineering services during design, implementation, and/or construction of any remedial measures, if necessary. This is to observe compliance with the concepts and recommendations contained herein and to allow design changes in the event that subsurface conditions differ from those anticipated.

APPENDIX B
PHASE II SCOPE OF WORK AND MODIFICATIONS

SCOPE OF WORK
PHASE II SITE INVESTIGATION
60 OLYMPIA AVENUE
WOBURN, MASSACHUSETTS

Prepared for:
Juniper Development
Winchester, Massachusetts

Prepared by:
Goldberg-Zoino & Associates, Inc.
Newton Upper Falls, Massachusetts

April 1989
File No. A-4596.1

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April 14, 1989
File No. A-4596.1-C,PC

Mr. Charles Whitten
Juniper Development Group
39 Holden Street
Winchester, Massachusetts 01890

Re: Scope of Work
Phase II Site Investigation
60 Olympia Avenue
Woburn, Massachusetts

Dear Mr. Whitten:

Pursuant to your recent request, attached please find a proposed Scope of Work for Phase II studies at the above-referenced site. The scope of work has been prepared in response to a letter from the Massachusetts Department of Environmental Quality Engineering (DEQE), dated March 17, 1989.

We appreciate the opportunity to assist you with this project. Please contact the undersigned should you have questions regarding the scope of work or require further assistance.

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.

Sara R. Hanna
Senior Technical Specialist

John J. Balco
Associate

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1.00 INTRODUCTION

The following document is a proposed Phase II Scope of Work for the Olympia Nominee Trust property at 60 Olympia Avenue in Woburn, Massachusetts. The proposed Scope of Work has been prepared by Goldberg-Zoino & Associates, Inc. (GZA) at the request of our Client, Olympia Nominee Trust, owner of the subject site. The Scope of Work is intended to comply with the requirements for a Phase II Scope of Work as defined in the Massachusetts Contingency Plan (MCP) (310 CMR 40.545(2)), and as required in a letter from the Department of Environmental Quality Engineering (DEQE) to Olympia Nominee Trust, dated March 17, 1989.

1.10 BACKGROUND

The subject property occupies approximately 21 acres of land on the south side of Olympia Avenue in an area of mixed industrial and commercial development in the north-central portion of Woburn. A site locus is presented on Figure 1. Approximately 8 acres are paved and utilized as a truck terminal. Remaining portions of the site are primarily wetlands along the Aberjona River.

Previous studies of the site have included an environmental site assessment of the property conducted by GZA in 1984 and 1985 for real estate transaction purposes¹; a report by Hidell-Eyster Technical Services describing the removal of underground tanks at the site²; and a hydrogeologic assessment of the site conducted by GZA in 1988³; these studies have indicated the presence of petroleum products in the soil and groundwater in the area where several underground petroleum product storage tanks were located (see Figure 2). In addition, various studies of the subject site and surrounding properties have been conducted by the U. S. Environmental Protection Agency (EPA) in relation to

¹Goldberg-Zoino & Associates, Inc., "Environmental Site Assessment, 60 Olympia Avenue, Woburn, Massachusetts," February 1985, GZA File No. Z-4596.

²Hidell-Eyster Technical Services, Inc., "Progress Report Relating to Underground Storage Tank Excavation for a Site Located at 60 Olympia Avenue, Woburn, Massachusetts (Project #05-8775)," November 9, 1987.

³Goldberg-Zoino & Associates, Inc., "Hydrogeologic Assessment, 60 Olympia Avenue, Woburn, Massachusetts," GZA File No. A-4596.1, October 1988.

contamination at the City of Woburn's Wells G and H; EPA has recently issued the Feasibility Study (FS) for the Wells G & H Superfund site. EPA's studies at the Wells G & H site have not included an evaluation of the presence and distribution of petroleum products in the soil or groundwater at the 60 Olympia Avenue property.

1.20 REQUIREMENTS FOR ADDITIONAL STUDY

On March 17, 1989, DEQE issued a letter to Olympia Nominee Trust "to define what additional actions are necessary to protect public health & the environment pursuant to M.G.L. Chapter 21E and the Massachusetts Contingency Plan 310 CMR 40.00." A copy of the letter is attached in Appendix A. Actions required by this letter include:

1. Removal or proper abandonment of two underground storage tanks currently on-site but presumably no longer in service, to be completed by June 1, 1989;
2. Removal of 350 cubic yards of contaminated stockpiled soil to an appropriate out-of-state disposal facility. The soil was generated during the removal and replacement of three underground storage tanks in June 1987; the DEQE letter indicates that the material must be removed from the site by April 14, 1989;
3. Initiation of interim recovery of free floating petroleum product which was detected in monitoring wells MW-1 and GZ-3; and
4. Implementation of a Phase II - Comprehensive Site Assessment in accordance with the Massachusetts Contingency Plan, focusing on the area of the underground storage tanks and the fuel pump islands.

The present work plan has been prepared pursuant to Item 4 above.

2.00 SCOPE OF WORK

The MCP states that requirements of a Phase II scope of work include:

- (a) a plan to fill in data gaps identified in Phase I and to perform the activities identified in 310 CMR 40.545(3);
- (b) (no entry in MCP);
- (c) a schedule for implementation of the Phase II - Comprehensive Site Assessment;

- (d) a sampling plan for all media, and analytical protocols;
- (e) a quality assurance/quality control plan; and
- (f) a health and safety plan, including measures to safeguard nearby residents.

These items are addressed below:

2.10 DATA TO BE GATHERED IN PHASE II (310 CMR 40.545(2)(a))

The U.S. EPA has developed extensive information on the vicinity of the 60 Olympia Avenue site during the course of studies related to Wells G & H; it is anticipated that much of the "regional" information required for a Phase II - Comprehensive Site Assessment has been developed by EPA and/or its subcontractors. New information to be gathered by GZA during the Phase II assessment of the Olympia Avenue site will be mainly site-specific information.

As previously stated, information available to date indicates the presence of petroleum products in the soil and groundwater in the vicinity of the former underground storage tanks at the site. Results of tank testing indicate that leakage from some of the tanks may have been the source of these contaminants. However, additional subsurface information is needed to further characterize the extent of soil and groundwater contaminated by petroleum products; to evaluate the potential presence of additional sources (e.g., piping, pump islands, surface spillage); and to evaluate the potential risks to human health, safety, public welfare and the environment posed by the site under existing and reasonably foreseeable land uses. More specific information on data to be gathered is presented in the following sections.

2.11 Field Exploration, Sampling, and Analysis

A soil gas survey will be conducted in the vicinity of the underground storage tanks and their associated piping and pump islands. Areas of particular interest include the area extending from north and west of the pump islands to the sewer easement and the vicinity of B-2, the vicinity of the waste oil tank, and the area to the south of MW-1 and GZ-3. In addition, several soil gas measurements will be made in the vicinity of boring B-4 in the southwest corner of the site, where trace levels of VOCs were detected by GZA in our 1988 hydrogeologic assessment of the site. (See Figure 2 for boring locations.) It is anticipated that soil gas will be evaluated at 30 to 40 locations.

Following the completion of the soil gas survey, a test boring and monitoring well installation program will be

conducted. It is currently anticipated that approximately 6 to 10 additional shallow wells will be installed, and that the borings will be located in the vicinity of the pump islands, and in the vicinity of a waste oil tank. At least one boring will be located near the sewer to provide additional information on groundwater flow directions in this area. Results of the soil gas survey will be used in selecting specific locations for the borings.

The shallow borings will be advanced using hollow stem auger techniques; the use of drilling water is not planned. Should water be required due to running sands in the borehole, potable water obtained from the City of Woburn will be used. The borings will be advanced to five to ten feet below the water table encountered during drilling. At the completion of drilling, an observation well consisting of 1.5 inch diameter PVC wellscreen attached to solid PVC riser will be installed in each borehole. No glue will be used in the construction of the wells. The wellscreen will be set to span the water table encountered during drilling, to evaluate the possible presence of floating petroleum product. A filter of clean silica sand will be placed in the annular space around the wellscreen, and a bentonite seal will be placed above the sand filter. Each well will be completed with a cast iron roadbox (in paved areas) or a locking protective casing.

Soil samples collected from the borings will be screened in the field with an HNU Model PI-101 photoionization detector or equivalent to evaluate relative concentrations of volatile organic compounds (VOCs); information gathered during drilling of the initial borings will be used in selecting locations for later borings. The samples may also be screened at GZA's laboratory to provide data gathered under more controlled conditions. Final boring locations will be presented in the Phase II report, along with a discussion of the rationale for selection of these boring locations.

In addition to the shallow borings, deeper borings will be installed to further characterize the vertical distribution of contaminants at the site, and to further characterize site stratigraphy. To allow the construction of adequate seals, to reduce the potential for cross-contamination, and to minimize potential problems with running sands, it is anticipated that drive-and-wash techniques will be utilized for the deeper borings; drilling water will be potable water obtained from the City of Woburn. Initially, two borings with observation wells are proposed at locations to be selected following the completion of the shallow drilling program; the borings would be advanced to refusal (i.e., to the bottom of the overburden materials). At least two borehole permeability tests will be conducted in each boring to evaluate aquifer parameters. Should results of analyses of soil or groundwater from these boring indicate the

presence of elevated concentrations of petroleum constituents at depth in the aquifer, additional deep borings will be installed to further characterize the extent and concentration of these materials.

Following completion of the new wells, relative wellhead elevations will be surveyed to allow further evaluation of groundwater flow directions.

2.12 Risk Assessment

Additional information which has not been developed to date but which is required under Phase II includes an evaluation of the risk to human health, safety, public welfare, and the environment posed by the site under existing and reasonably foreseeable land uses. A risk assessment will be prepared for the site, in accordance with DEQE guidelines ("Draft Interim Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan," DEQE, October 3, 1988).

Specific items to be addressed include an evaluation of wetlands and critical habitats; additional description of the environmental fate and transport of the detected contaminants; and identification of exposure points and exposure point concentrations.

Appendix B presents a checklist of MCP Phase II requirements and a summary of activities which have been performed to date, and activities proposed under this Scope of Work.

2.20 PROJECT SCHEDULE (310 CMR 40.545(2)(c))

It is anticipated that the Phase II assessment will require approximately 20 weeks to complete. A schedule for the completion of the Phase II - Comprehensive Site Assessment is presented in Table 1. Note that commencement of the Phase II study is contingent upon receipt of DEQE approval of this Work Plan; thus, the proposed timetable indicates the amount of time anticipated to be required to complete the work, but does not include an absolute date of completion of the various portions of work or of the entire Phase II assessment.

2.30 SAMPLING PLAN (310 CMR 40.545(2)(d))

Samples of site soil, groundwater, and surface water will be collected as part of the Phase II assessment, as described below.

2.31 Soil

Soil samples will be collected from each of the new borings to be installed under Section 2.10 above. The split spoon sampler will be decontaminated between sampling attempts using

clean water, followed by a methanol rinse, followed by an additional clean water rinse. Each of the soil samples will be screened for VOCs using an HNU Model PI-101 photoionization detector or equivalent, and using DEQE's Jar Headspace Method (Appendix C). The samples will be screened in the field, and also in GZA's laboratory under more controlled temperature conditions.

Selected soil samples will be submitted to an outside laboratory for petroleum hydrocarbon (PHC) analysis by the IR method (Method 418.1). It is anticipated that at least one sample from each boring at which HNU readings greater than 10 parts per million (ppm) (referenced to a benzene standard), and one sample representative of "background" conditions, or three to five samples, whichever is greater, will be submitted for PHC analysis. Selected samples yielding elevated HNU readings will also be submitted for petroleum hydrocarbon fingerprinting analysis (U.S. Coast Guard Marine Petroleum Hydrocarbon Scan) to identify the type(s) of petroleum compounds present.

In addition, selected soil samples (a minimum of one per boring, generally the sample exhibiting the highest HNU reading) will be screened for VOCs at GZA's Newton laboratory using a Hewlett-Packard Model 5890A gas chromatograph (GC) and static headspace techniques. GZA's soil screening methods are presented in Appendix D. Chlorinated VOCs have been reported in the vicinity of the waste oil tank; at least one soil sample from this vicinity, and samples from any other areas at which chlorinated VOCs may be detected, will be submitted for quantitative analysis for VOCs by EPA Method 8240.

2.32 Groundwater

Groundwater samples will be collected from each of the newly installed wells, and from the wells previously installed by GZA, Hidell-Eyster, and others (B-2A and B-3A). It is not anticipated that EPA's wells on the west side of the Aberjona River will be sampled as part of the present study. The samples will be collected using separate (i.e., one per well) pre-cleaned stainless steel bailers with teflon ballcheck valves. Prior to sample collection, each well will be bailed until three times the volume of standing water has been removed. For wells installed in borings in which drilling water was used, GZA will purge the wells by pumping with a centrifugal pump until the approximate volume of drilling water has been removed, prior to the start of sampling activities. The pH and conductivity of the discharge water will be monitored during the purging activities to evaluate when the water quality has stabilized.

A groundwater sample from each well will be screened by GZA for volatile organic compounds using the HP GC and static

headspace techniques. GZA's GC screening procedures for water samples are attached in Appendix E.

Six to ten groundwater samples will be submitted for PHC analysis by the IR method (Method 418.1), and two to four samples will be submitted for petroleum hydrocarbon fingerprinting (U.S. Coast Guard Marine Hydrocarbon Scan). In addition, groundwater samples from existing well B-3A adjacent to the waste oil tank, at which chlorinated solvents have been reported, and groundwater from the additional borings to be installed in this area, and/or other wells at which chlorinated solvents are detected in GZA's GC screening process will be submitted for analysis for VOCs by EPA Method 624.

2.33 Surface Water

Surface water samples will be collected from two locations (SW-1 and SW-2) along the Aberjona River, as indicated on Figure 2. The samples will be grab samples collected directly in the sample containers. The samples will be screened for VOCs at GZA's Newton laboratory.

2.34 Air

Because the available data indicate that the petroleum products at the site are isolated from direct human contact by the presence of the overlying unsaturated soils, it is not anticipated that the materials contained in the soil and groundwater are currently having a significant impact on air quality. Field activities proposed under this Scope of Work are also not anticipated to result in the release of significant quantities of contaminants to the atmosphere. Therefore, no extensive air sampling is proposed. Air at the site will be monitored using an HNU Model PI-101 photoionization analyzer during field activities; should the HNU monitoring indicate the presence of elevated concentrations of VOCs, the DEQE will be notified and a program for further air sampling will be developed and implemented. Note that DEQE's March 17, 1989 letter requires the piles of contaminated soil generated during the previous tank removals to be removed from the site prior to the commencement of Phase II studies, and that removal of the additional underground tanks at the site is not part of this Phase II assessment; thus, potential air emissions and/or generation of dust from these soils are not covered by this Scope of Work.

2.40 QUALITY ASSURANCE/QUALITY CONTROL PLAN (310 CMR 40.545 (2)(e))

The following quality assurance/quality control procedures will be implemented during the Phase II assessment of the 60 Olympia Avenue site:

- field screening instruments will be calibrated daily in accordance with manufacturer's instructions;
- one duplicate sample will be submitted for every ten samples to be analyzed, for each medium analyzed;
- at least one trip blank, field blank, and bailer blank will be prepared for each ten groundwater or surface water samples submitted for analysis (bailer blanks apply to groundwater samples only);
- laboratories utilized for quantitative analysis will be certified by DEQE for the analyses being conducted;
- chain-of-custody procedures will be maintained for samples collected for laboratory analysis;
- quantitative analyses will be conducted according to approved protocols, as described in Section 2.30 above.

2.50 HEALTH AND SAFETY PLAN (310 CMR 40.545 (2)(f))

A Health and Safety Plan for the Phase II work at the site is attached as Appendix F. As previously noted, it is not anticipated that field activities to be conducted as part of the Phase II assessment will have a measurable impact on nearby residences, the nearest of which is approximately 800 to 1000 feet to the east of the site. Should on-site monitoring conducted during the field work indicate that the field activities may pose a risk to residents, work will be terminated until appropriate health and safety plans have been developed.

3.00 PHASE II REPORT (310 CMR 40.545 (4))

At the completion of Phase II activities, GZA will prepare a Phase II report (310 CMR 40.545 (4)), including:

- (a) a summary of findings;
- (b) the Phase II scope of work;
- (c) a description of physical site characteristics;
- (d) a description of the source(s) and extent of release(s);
- (e) a characterization of oil or hazardous materials;
- (f) an identification of exposure points and determination of exposure point concentrations;

- (g) an identification of background levels of oil or hazardous materials;
- (h) a characterization of the risk of harm to human health;
- (i) a characterization of the risk of harm to safety, public welfare, and the environment;
- (j) conclusions;
- (k) recommendations for future actions; and
- (l) tables, figures, and appendices, including raw data, data summaries, and documentation of revisions to the approved scope of work.

TABLE

TABLE 1
ESTIMATED PROJECT SCHEDULE

WEEKS

[illegible]

FIGURES

APPENDIX A

DEQE LETTER DATED MARCH 17, 1989



Metropolitan Boston - Northeast Region

5A Commonwealth Avenue

Woburn, Massachusetts 01801

Daniel S. Greenbaum
Commissioner
935-2160

March 17, 1989

Mr. Charles Whitten
Olympia Nominee Trust
39 Holton Street
Winchester, MA 01890

RE:WOBURN-60 Olympia Avenue
DEQE Case No. 3-594

Dear Mr. Whitten:

This letter is written in regard to the condition of environmental contamination at the 60 Olympia Avenue property, previously documented by the Department in a Notice of Responsibility letter dated August 18, 1986. Further remedial and investigatory activities have occurred since that time including the removal of three underground storage tanks containing petroleum in June 1987 and a hydrogeologic assessment conducted by Goldberg, Zoino & Associates, Inc. (GZA) in 1988.

Reports documenting the above response actions have been submitted and reviewed by the Department. The purpose of this letter is to define what additional actions are necessary to protect public health & the environment pursuant to M.G.L. Chapter 21E and the Massachusetts Contingency Plan 310 CMR 40.00.

As you are aware, the subject site is within the boundaries of the Federal Superfund Site Wells G & H, currently under investigation by the Environmental Protection Agency and the Department of Environmental Quality Engineering. A remedy for clean-up of the Wells G & H Site has been proposed and the final determination of the remedial action will be made within the next three months. It is imperative that response actions concerning the contamination at and from the area of the underground storage tanks on the Olympia Nominee Trust property be conducted in a timely manner so as not to impact the progress of remediating the aquifer surrounding Wells G & H. Due to the immediacy of this matter, the Department has determined that the following actions must be conducted within the time frame specified.

Requisite Site Actions

1. Removal or proper abandonment of two underground storage tanks currently on-site but presumably no longer in service. According to information submitted to the Department in November 1987, two tanks including 1-1,000 gallon waste oil tank and 1-5,000 gallon diesel fuel tank remain on site but are out of service. As reported by Linda Swarms in November 1987, 1-6,380 gallon tank and 1-5,000 gallon tank were removed in July 1983 by Craftsmen Construction. At the same time, two new tanks were installed with the capacity of 6,280 gallons and 5,000 gallons. According to a proposal dated June 14, 1983 and an invoice dated August 2, 1983, prepared by Craftsmen Construction, only one tank was removed from the property in July 1983, having the capacity of 6,280 gallons. Therefore, the status of 1-5000 gallon underground diesel fuel tank remains unaccounted for and is presumed to be still on-site. The removal or proper abandonment of the two underground storage tanks are required under section 9.22 of 527 CMR 9.00, the Board of Fire Prevention Regulations, and 310 CMR 30.00 Hazardous Waste Regulations. This action must be conducted no later than June 1, 1989.
2. Removal of 350 cubic yards of contaminated stockpiled soil to an appropriate out-of-state disposal facility. This material was generated during the removal and replacement of three underground storage tanks in June 1987. Due to the presence of tetrachlorethene in the soil, it is not eligible for recycling at an asphalt batching facility. This was conveyed to Mr. Peter Brown in a telephone conversation on December 14, 1988. More than sufficient time has elapsed for the proper disposition of this material to have occurred. The Department requires that this material be removed from the site and transported to an appropriate disposal facility no later than April 14, 1989.
3. Initiate interim recovery of free floating petroleum product which was detected in monitoring wells MW-1 and GZ-3. Product removal should commence immediately using a hand bailer and continue on a weekly basis until no further product is observed in the wells. Records of product thickness and the volume of petroleum recovered from the wells should be maintained and submitted to the Department.
4. Implement a Phase II-Comprehensive Site Assessment in accordance with the Massachusetts Contingency Plan focusing on the area of the underground storage tanks and the fuel pump islands. A Phase II Scope of Work must be submitted to the Department for approval prior to implementing the investigation. The scope of work must be received by the Department no later than April 14, 1989.

All time tables stipulated within this letter are adopted by the Department as interim deadlines pursuant to its authority under M.G.L. Chapter 21E and 310 CMR 40.535(5).

If you have further questions regarding this matter, please contact Rodene DeRice at the letterhead address or phone (617)935-2160. All further communications regarding this site must reference the DEQE case number designated in the subject heading.

Very Truly yours,

Rodene A. DeRice

Rodene A. DeRice
Environmental Analyst

Richard J. Chalpin
Richard J. Chalpin
Deputy Regional
Environmental Engineer

RJC/RAD/ram

cc: DEQE/DHW, 1 Winter St., Boston, MA 02108
BOH, 33 Plympton St., Woburn, MA 01801
Barbara Newman, Waste Management Division, U.S. EPA, JFK Bldg. HRS-CAN3
Boston, MA 02203
Mr. John Balco, Goldberg Zoino & Assoc., 320 Needham St., Newton Upper
Falls, MA 02164
Mr. Bill Murphy, Woburn Conservation Comm., 33 Plympton St., Woburn, MA
01801

APPENDIX B
PHASE II ACTIVITIES CHECKLIST

PHASE II ACTIVITIES CHECKLIST

Phase II Activity (310 CMR 40.545(3))

Status

- (a)1. site locus and site plans previously developed; existing plans will be updated to include UTM and latitude/ longitude coordinates, and locations of additional explorations.
2. characterization of topography and surface drainage completed. Characterization of vegetation partially completed. Additional characterization of vegetation to be completed under Phase II.
3. completed
4. to be completed under Phase II (review of FEMA information)
5. to be completed under Phase II
6. shallow soils have been characterized during previous studies; regional geology characterized by EPA for G & H Wells Superfund site; additional site- specific information to be developed for deeper overburden materials during Phase II.
7. types of bedrock and regional information on depth to bedrock characterized by EPA; additional site- specific information to be developed during Phase II.
8. water table elevations and horizontal flow directions previously evaluated in GZA hydrogeologic study. Additional information regarding vertical gradients to be developed in Phase II via installation of deep wells.
9. identification of existing land uses complete; evaluation of foreseeable land uses to be done under Phase II.
10. characterized by EPA for G & H wells site

11. information regarding locations of utility lines has been developed during earlier studies at the site; information will be plotted on drawing to be submitted in Phase II report. The Woburn Sewer Department will be contacted with regard to construction details for the sewer line (e.g., bedding material, etc.)
12. other information will be as required to complete Phase II.
- (b)1. former underground tanks have been identified as possible sources of oil or hazardous materials. Phase II will include an evaluation of additional possible sources including tank piping, pump islands, and/or surface spillage which may have occurred during vehicle refueling or tank filling.
2. the horizontal extent of oil or hazardous material has been generally evaluated during previous studies. Additional information to refine evaluation of horizontal extent, and information regarding vertical extent of oil or hazardous material, will be developed in Phase II.
3. volume estimates will be prepared following completion of evaluation of horizontal and vertical extent of contamination (Item (b)2 above).
4. evaluation of potential migration pathways will be completed following evaluation of extent and distribution of oil or hazardous material.
5. groundwater contaminant plume has been partially characterized during previous studies; additional information to be gathered during Phase II will allow further definition of extent of plume and further evaluation of its potential migration.
6. air emissions to be re-evaluated during Phase II field activities.

- (c) 1. type and composition of contaminants has been previously characterized; volume to be further evaluated following completion of additional exploration, sampling and analysis under Phase II.
2. partially completed; to be described and further evaluated in Phase II.
- (d) 1 through 4. to be conducted in Phase II.
- (e) soil and groundwater samples from areas of the site upgradient of the underground tanks have been collected and analyzed during previous sampling rounds; one to two confirmatory samples to be collected during Phase II.
- (f) several maps have been prepared during previous studies, including maps showing physical site characteristics, identified possible sources of oil or hazardous material, and groundwater elevation contours. Additional drawings will be prepared to show the extent and concentration of oil or hazardous materials, and projected future migration of contaminant plume(s); existing drawings will be updated to include additional information generated during Phase II.
- (g), (h), (i), (j) to be conducted during Phase II

Note: Refer to Massachusetts Contingency Plan (310 CMR 40.545(3) for description of Phase II activities (copy attached). Previous studies listed in text of work plan.

APPENDIX C
DEQE JAR HEADSPACE PROCEDURE

JAR HEADSPACE ANALYTICAL SCREENING PROCEDURE

The following are recommended procedures for conducting analytical screening of gasoline contaminated soils utilizing a portable Photoionization Detector (PID) or Flame Ionization Detector (FID):

- (1) Half-fill two clean glass jars with the sample to be analyzed. Quickly cover each open top with one or two sheets of clean aluminum foil and subsequently apply screw caps to tightly seal the jars. 16 oz (approx 500 ml) soil or "mason" type jars are preferred; jars less than 8 oz (approx 250 ml) total capacity may not be used.
- (2) Allow headspace development for at least 10 minutes. Vigorously shake jars for 15 seconds both at the beginning and end of the headspace development period. Where ambient temperatures are below 32 F (0 C) headspace development should be within a heated vehicle or building.
- (3) Subsequent to headspace development, remove screw lid/expose foil seal. Quickly puncture foil seal with instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates.

As an alternative, syringe withdrawal of a headspace sample with subsequent injection to instrument probe or septum-fitted inlet is acceptable contingent upon verification of methodology accuracy using a test gas standard.
- (4) Following probe insertion through foil seal and/or sample injection to probe, record highest meter response as the jar headspace concentration. Using foil seal/probe insertion method, maximum response should occur between 2 and 5 seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data should be discounted.
- (5) The headspace screening data from both jar samples should be recorded and compared; generally, replicate values should be consistent to plus or minus 20%.
- (6) PID and FID field instruments shall be operated and calibrated to yield "total organic vapors" in ppm (v/v)

as benzene. PID instruments must be operated with a 10.0 eV (+/-) lamp source. Operation, maintenance, and calibration shall be performed in accordance with the manufacturer's specifications. For jar headspace analysis, instrument calibration shall be checked/adjusted no less than once every 10 analyses, or daily, whichever is greater.

- (7) Instrumentation with digital (LED/LCD) displays may not be able to discern maximum headspace response unless equipped with a "maximum hold" feature or strip-chart recorder.

Deviations, departures and/or additions to the above procedures will be considered on a case-by-case basis by the DEQE on-scene coordinator or project manager. In such cases, compelling technical justification must be presented and documented by the methodology proponent.

Received

FEB 11 1989

APPENDIX D
GZA SOIL SCREENING PROCEDURES

GZA RAPID VOLATILE ORGANIC SCREENING OF SOIL SAMPLES BY THE STATIC HEADSPACE TECHNIQUE

SAMPLE PREPARATION AND ANALYTICAL METHODOLOGY

OVERVIEW

The GZA rapid screening technique for volatile organics in soil estimates concentrations of these compounds from gaseous concentrations measured in air above the sample. The method attempts to measure concentrations of contaminants released from the soil samples into the headspace. A subsample of soil is added to a ten milliliter crimp top vial and immediately sealed. The weight of the soil is determined and used to calculate the concentration. This method has been developed by the GZA Environmental Chemistry Laboratory as a rapid, reasonably accurate and reliable, and cost effective screening of soil samples for volatile organics. However, this technique is not definitive and is not an EPA approved analytical method.

METHODOLOGY

Soil samples taken in the field are placed in 250 ml glass jars with a teflon gasket lid. The samples are kept at 4 degrees C until the time of analysis. A 10 ml crimp top septum vial is marked and tared with a crimp top on an analytical balance. A subsample of soil is added until all but a 2.5 ml volume of headspace remains. The vial cap is immediately crimped on and the weight of the vial and its contents is again measured to determine the weight of soil added. A 1.0 ml aliquot of headspace gas is withdrawn automatically by a Hewlett Packard 19395A headspace injector. The headspace sample is injected into the sample port of a HP 5890A gas chromatograph where the vapor is split within the injection port and distributed to two 30 meter X 530 micron fused silica capillary columns. Concentrations of eluting volatile organics are measured with dual flame ionization detectors and response data are acquired by a Nelson Analytical 760 Series Intelligent Interface. The chromatographic data are transmitted to an IBM AT personal computer and analyzed using the Nelson Analytical 2600 Series Chromatography Software. The information for the analytical report is entered manually onto a Lotus Symphony spreadsheet.

CALIBRATION

The response of the gas chromatograph is calibrated with external standards prepared for concentrations of 0.1, 1.0, and 10 ug/g (ppm) and introduced into the chromatograph as headspace samples in the same manner as unknown soil samples. Sample peaks are identified by comparing their retention times from both columns to measured retention times of calibration standards for both columns. Qualitative comparisons are made between the two sets of test data for each sample. Sample peaks identified as known compounds are quantified according to response factors determined from calibration standards.

REPORT FORMAT

The method detection limit (MDL) for each compound is stated for every report with 95% certainty in an average chromatographic run. Concentrations measures in the range of 1 to 5 times the MDL are reported as "Trace". Concentrations less than the MDL may be identified as beneath the method detection limit (BMDL) in instances where the compound's presence is 95% certain in that particular chromatogram. The total concentration for all detected compounds for which a calibration has been made, except methane, is summarized in the row designated as "Total Compounds"; none detected, ND, is reported if no known peaks are found. Unidentifiable peaks are reported as "Present" and the number of unknown peaks are reported in parentheses. No unknown peaks detected is reported as "ND".

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QUALITY CONTROL

The GZA procedure assumes that response factors are constant over the working range of 10 ppb to 10 ppm and that the precision of the analysis for samples is the same as that for the calibration standards. The 95% confidence limits for a measurement are defined as plus or minus two standard deviations as determined by a Student's t Test on replicate analyses of calibration standards. Quality control standards are analyzed daily and accepted if the relative standard deviation of the response factor is less than 20% of the anticipated value. New calibration curves are prepared when quality control limits are exceeded. Method blanks are prepared in the same manner as samples and are analyzed before each job or no less frequently than every six samples. Field blanks and duplicates are submitted at the discretion of the sample submitter.

DISCLAIMER

Identities and concentrations of volatile organic compounds reported by this headspace screening technique are subject to limitations inherent to this method. If confirmation is desired, duplicate samples should be submitted to a State certified laboratory for analysis by the appropriate EPA protocol methods.

Laboratory Sample Notation:

S - Soil SOL - Solid SD - Sediment SL - Sludge B - Blank

Laboratory Contact Person:

Edward W. Pickering
Environmental Chemistry Laboratory Manager
Phone #: (617) 969-0050, x169

REFERENCES

- Ettre, L.S., B. Kolb, and S.G. Hurt, "Techniques of headspace gas chromatography," Am. Lab. 15 (10), 76-83, (1983).
- Jones, E., M. Davis, R. Gibson, and R. Wallen, "Applications of headspace GC to complex liquid samples," Am. Lab. 16 (8) 74-81, (1984).
- McNally, M.E., and R.L. Grob, "A review: Current applications of static and dynamic headspace analysis: Part one: Environmental Applications," Am. Lab. 17 (1) 20-33, (1985).
- Spittler, T.M., R. Siscanaw, M. Lataille, and P.A. Parks, "Correlation between field GC measurement of volatile organics and laboratory confirmation of collected field samples using GC/MS," Paper presented at 11/82 Washington, D.C., Hazardous Materials Control Research Institute Conference.
- Wylie, P.L., "Trace Analysis of Volatile Compounds in Water Using the HP 19395A Headspace Sampler", Hewlett-Packard Application Note AN 228-40 (1985).

May, 1988/EWP

APPENDIX E
GZA WATER SCREENING PROCEDURES

GZA RAPID VOLATILE ORGANIC SCREENING OF WATER SAMPLES BY THE STATIC HEADSPACE TECHNIQUE

SAMPLE PREPARATION AND ANALYTICAL METHODOLOGY

OVERVIEW

The GZA rapid screening technique for volatile organics in water estimates aqueous concentrations of these compounds from gaseous concentrations measures in air over the sample. Dissolved volatile organics are driven from the water phase by equilibrating at an elevated temperature in a hermetic system containing the sample and clean air. An aliquot of the equilibrated headspace gas is injected into the chromatograph to provide an evaluation of the quality of the water sample. This method has been developed by the GZA Environmental Chemistry Laboratory as a rapid, reasonably accurate and reliable, and cost effective screening of water samples for volatile organics. However, this technique is not definitive and is not an EPA approved analytical method.

METHODOLOGY

Water samples taken in the field are placed in 40 ml glass septum vials filled to capacity and capped to exclude air bubbles. Vials are kept at 4 degrees C to preserve the sample until the time of analysis. In preparing the sample for analysis, a volume ratio of 3:1 sample to headspace (air) is created by discarding 10 ml of sample (replaced by air) from the 40 ml vial or transferring 7.5 ml to a 10 ml crimp-top septum vial. The vial is resealed and heated to 40 degrees C in a thermostatically controlled bath. A 1.0 ml aliquot of headspace gas is withdrawn manually with a syringe or automatically by a Hewlett Packard 19395A headspace injector. The headspace sample is injected into the sample port of a HP 5890A gas chromatograph where the vapor is split within the injection port and distributed to two 30 meter X 530 micron fused silica capillary columns. Concentrations of eluting volatile organics are measured with dual flame ionization detectors and response data are acquired by a Nelson Analytical 760 Series Intelligent Interface. The chromatographic data are transmitted to an IBM AT personal computer and analyzed using the Nelson Analytical 2600 Series Chromatography Software. The information for the analytical report is entered manually onto a Lotus Symphony spreadsheet.

CALIBRATION

The response of the gas chromatograph is calibrated with external standards prepared for concentrations of 0.1, 1.0 and 10 ug/l (ppm) and introduced into the chromatograph as headspace samples in the same manner as unknown water samples. Sample peaks are identified by comparing their retention times from both columns to measures retention times of calibration standards for both columns. Qualitative comparisons are made between the two sets of test data for each sample. Sample peaks identified as known compounds are quantified according to response factors determined from calibration standards.

REPORT FORMAT

The method detection limit (MDL) for each compound is stated for every report with 95% certainty in an average chromatographic run. Concentrations measures in the range of 1 to 5 times the MDL are reported as "Trace". Concentrations less than the MDL may be identified as beneath the method detection limit (BMDL) in instances where the compound's presence is 95% certain in that particular chromatogram. The total concentration for all detected compounds for which a calibration has been made, except methane, is summarized in the row designated as "Total Compounds"; none detected, ND, is reported if no known peaks are found. Unidentifiable peaks are reported as "Present" and the number of unknown peaks are reported in parentheses. No unknown peaks detected is reported as "ND".

QUALITY CONTROL

The GZA procedure assumes that response factors are constant over the working range of 10 ppb to 10 ppm and that the precision of the analysis for samples is the same as that for the calibration standards. The 95% confidence limits for a measurement are defined as plus or minus two standard deviations as determined by a Student's t Test on replicate analyses of calibration standards. Quality control standards are analyzed daily and accepted if the relative standard deviation of the response factor is less than 20% of the anticipated value. New calibration curves are prepared when quality control limits are exceeded. Method

DISCLAIMER

Identities and concentrations of volatile organic compounds reported by this headspace screening technique are subject to limitations inherent to this method. If confirmation is desired, duplicate samples should be submitted to a State certified laboratory for analysis by the appropriate EPA protocol methods.

Laboratory Sample Notation:

GW - Groundwater SW - Surface Water WW - Waste Water B - Blank

Laboratory Contact Person:

Edward W. Pickering
Environmental Chemistry Laboratory Manager
Phone #: (617) 969-0050, x169

REFERENCES

- Ettre, L.S., B. Kolb, and S.G. Hurt, "Techniques of headspace gas chromatography," Am. Lab. 15 (10), 76-83, (1983).
- Jones, E., M. Davis, R. Gibson, and R. Wallen, "Applications of headspace GC to complex liquid samples," Am. Lab. 16 (8) 74-81, (1984).
- McNally, M.E., and R.L. Grob, "A review: Current applications of static and dynamic headspace analysis: Part one: Environmental Applications," Am. Lab. 17 (1) 20-33, (1985).
- Spittler, T.M., R. Siscanav, M. Lataille, and P.A. Parks, "Correlation between field GC measurement of volatile organics and laboratory confirmation of collected field samples using GC/MS," Paper presented at 11/82 Washington, D.C., Hazardous Materials Control Research Institute Conference.
- Wylie, P.L., "Trace Analysis of Volatile Compounds in Water Using the HP 19395A Headspace Sampler", Hewlett-Packard Application Note AM 228-40 (1985).

May, 1988/ENP

APPENDIX F
HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

GOLDBERG-ZOINO & ASSOCIATES, INC.

This plan is applicable for sites where the work involves the evaluation of potential chemical contamination (ENVIRONMENTAL SITE ASSESSMENTS), and where historical review, previous sampling results, site location, or other considerations indicate that the major chemical contaminants suspected are:

PETROLEUM PRODUCTS--GASOLINE and/or OILS & GREASE

JOB NAME Phase II Study, Olympia Nominee Trust NO. A-4596.1SITE LOCATION 60 Olympia Avenue, Woburn, MA.SITE DESCRIPTION/NATURE OF WORK Site is a trucking terminal.

Field work will include soil gas survey, test borings, well installation, and groundwater and surface water sampling for a Phase II study under the Mass. Contingency Plan.

DIG SAFE NOTIFIED? * BY WHOM _____ DATE _____

RESPONSE _____

DIG SAFE FILE NO. _____

PRIMARY LEVEL OF PROTECTION: Level D or Modified Level D, as appropriateCONTINGENCY LEVEL OF PROTECTION: Level CMAP OF ROUTE TO NEAREST HOSPITAL ATTACHED: YES ✓ NO _____EMERGENCY PHONE NUMBERS 911AMBULANCE: 933-3131 FIRE: 933-3131 POLICE: 933-1212HOSPITAL: Name Choate HospitalAddress 21 Warren Avenue, Woburn, MAHospital Phone Number 933-6700

OTHER: _____ PHONE NO. _____

PHONE NO. _____

LOCATION OF NEAREST PHONE: at site

*Digsafe will be notified more than 72 hrs ~~and~~ and less than 30 days prior to the start of field work. Start date is dependent on receipt of DEQE approval of Scope of work for Phase II.

SITE HAZARDS

PETROLEUM PRODUCTS KNOWN OR SUSPECTED TO BE PRESENT:

gasoline, fuel oil. There is also a waste oil tank on site. Low-level chlorinated solvents (<1 ppm) have been detected in one boring adjacent to waste oil tank.

SOURCE AND EXPECTED LOCATION OF CHEMICAL CONTAMINATION: _____

There are currently underground tanks on site; additional tanks have been removed. Some of the tanks failed permeability tests \Rightarrow tank leakage is probable source. Add'l sources may include leaks in piping and/or surface spillage.

OTHER SITE-SPECIFIC CONSIDERATIONS: _____

No other site specific considerations regarding oil or hazardous material. Site is a trucking terminal \Rightarrow use caution around trucks.

ROUTES OF EXPOSURE, SYMPTOMS, HEALTH EFFECTS:

Fuel oils are generally low in toxicity, they have low volatility, and are not readily absorbed through the skin, however they may cause skin irritation, or "dermatitis", upon contact.

Waste oils may contain certain cancer-causing components such as heavy metals and oil derivatives which can be absorbed through the skin.

Gasoline is considered more toxic than oils, it has relatively high volatility, and certain components are readily absorbed through the skin. Gasoline contains certain components, such as benzene, which are classified as potential carcinogens. The Threshold Limit Value for gasoline is 300 ppm.

The symptoms of inhalation over-exposure to petroleum products include dizziness, loss of coordination, general malaise, and nausea.

PHYSICAL HAZARDS:

If drilling, the general types of hazards associated with a drill rig are present, namely, slips and falls, falling objects, hand, foot and back injuries, etc. If digging test pits, the additional hazards of a swinging backhoe bucket, collapse of excavation, etc., exists.

NOISE HAZARDS:

The noise associated with operation of a drill rig or other heavy equipment can cause permanent, irreversible hearing loss. "Impact noise", such as that caused by driving a well point or split spoon with a drill rig hammer, is especially dangerous. Proper hearing protection (ear muffs or plugs) should be used when working near a source of loud noise.

SITE PERSONNEL REQUIREMENTS

MEDICAL MONITORING: Site personnel must participate in GZA's medical monitoring program and must have had their most recent exam within the previous 12 months. The exam must have indicated no medical restrictions that would inhibit personnel from performing the required work tasks.

HEALTH & SAFETY TRAINING: Site personnel must have had at least 40 hours of relevant health and safety training and/or equivalent experience which included coverage of hazard recognition, use of site monitoring instruments, use of personal protective equipment, etc.

SITE HEALTH & SAFETY PROCEDURES

PROCEDURES FOR NON-INTRUSIVE WORK (Site "Walk-Over", Geophysical Work, etc.):

No special procedures or equipment required
for non-intrusive work-

PROCEDURES FOR INTRUSIVE SITE WORK (Drilling, Test Pits, etc.):

A. PERSONAL PROTECTIVE EQUIPMENT:

1. "Ready bags" should be present at the site. (See the Ready Bag Checklist attached to this plan.)

B. MONITORING EQUIPMENT:

Photo-Ionization Detector (PID): H-Nu, 10.2eV, or equivalent PID

O₂ / LEL meter

- C. OTHER EQUIPMENT: An alternative to the PID, is the Sensadyne
Gastech Pump with indicator tube for petroleum hydrocarbons

D. SITE CONTROL:

Do not allow visitors, onlookers, or other unauthorized personnel within 25 feet of drill rig, test pit, etc. If work site is located in an unsecured area with possible pedestrian access, mark off work area with traffic cones, caution tape, warning placards, etc., as appropriate.

E. WORK PROCEDURES (also see Section G, "Site-Specific H & S Procedures"):

- * Begin working in Level D (Standard Work Clothes, Boots, Hardhats), unless Section G, calls for Modified D.
- * No Smoking near borehole or test pit.
- * Wear hearing protection if working near an operating drill rig or other source of loud noise.
- * Wear Bayprene or Nitrile gloves when handling soil samples.
- * Monitor soils with the PID (and O2/LEL meter if specified above).
- * If soils contaminated with oil and/or gasoline are encountered, proceed with Modified Level D protection, as appropriate (overboots, Tyvek suit, chemical-protective gloves, etc.), and monitor the breathing zone as well as soils with the PID (and O2/LEL meter if specified above).
- * Be prepared to elevate to Level C protection. Observe action levels as provided below.

IMPORTANT: IF SITE PERSONNEL SHOW SIGNS AND SYMPTOMS OF CHEMICAL EXPOSURE, DISCONTINUE WORK AND FOLLOW APPROPRIATE EMERGENCY PROCEDURES!

IF SITE OBSERVATIONS, ODORS, OR ANY OTHER INFORMATION INDICATES THAT CONTAMINANTS OTHER THAN PETROLEUM PRODUCTS ARE PRESENT, STOP WORK, AND CONTACT THE PROJECT MANAGER OR HEALTH & SAFETY REP. FOR FURTHER INSTRUCTIONS. IF FURTHER INSTRUCTIONS ARE NOT AVAILABLE, DISCONTINUE WORK AT THAT LOCATION.

F. ACTION LEVELS

1. Photo-Ionization Detector--breathing zone readings:

0 to 25ppm.....remain in Modified Level D (or Level D if appropriate)

> 25ppm.....go to level C

At levels consistently above 100 ppm in the breathing zone, discontinue working at that location and notify the Project Manager and Health & Safety Rep.

2. ² O2/LEL Meter (if specified in Section B above):

- * If oxygen levels in the breathing zone go below 19.5%, leave the work area temporarily until vapors dissipate. If oxygen deficiency continues to be a problem, discontinue work at that location and consult with health & safety rep. regarding necessary precautions.
- * 0 to 25% LEL near soils...work with caution
- * > 25% LEL near soils.....discontinue working at that location and make arrangements for vapor control (i.e. foam, etc.)

G. SITE-SPECIFIC H & S PROCEDURES: The LEL for gasoline is 1.3%

or 13,000 ppm. ~~Take proper precautions to prevent fire if vapor levels near the drilling spoils exceeds the detection range of the HNU (2000 ppm) or the indicator tubes (1000 ppm).~~

H. PERSONNEL & EQUIPMENT DECONTAMINATION:

- * Remove gross contamination from tools, respirator, monitoring equipment, boots, etc. prior to leaving the work-site, using water, paper towels, handi-wipes, etc.
- * Either completely decontaminate soiled equipment at the work-site using detergent & water (if possible), or wrap equipment in plastic bag for transport until complete decontamination is possible.
- * Dispose of contaminated gloves, Tyvek suits, used cartridges, paper towels, etc. by placing in a plastic bag and discarding in regular trash.
- * Wash hands & face thoroughly with soap and water before lunch or coffee breaks, and as soon as practicable after finishing work for the day.

EMERGENCY PROCEDURES

PERSONAL INJURY--Administer appropriate first aid. If injury is serious, transport the victim to the nearest hospital. If possible, notify hospital in advance of incoming patient and nature of injury. If there is a question about whether it is safe to move the victim, DO NOT move the victim--instead, make him/her as comfortable as possible, and summon emergency assistance.

CHEMICAL EXPOSURE--If site personnel show signs of inhalation exposure, retreat to fresh air for recovery. If symptoms are serious, such as nausea or fainting, bring the victim to the nearest hospital for observation, and discontinue work at that location and consult with H & S representative.

In case of skin or eye irritation due to chemical contact, wash affected skin with soap and water, or flush eyes with generous amounts of water. If irritation is serious, seek medical attention.

FIRE--If fire can be easily contained and extinguished, do so with fire extinguisher. If explosion risk is present, do not attempt to extinguish--evacuate all personnel to a safe area and call the fire department.

IMPORTANT NOTE: IF SITE OBSERVATIONS, SAMPLING RESULTS, OR ANY OTHER INFORMATION INDICATES THE PRESENCE OF CHEMICAL CONTAMINANTS OTHER THAN PETROLEUM PRODUCTS, THIS HEALTH & SAFETY PLAN BECOMES VOID, AND A NEW PLAN MUST BE PREPARED AND APPROVED!

PROJECT MANAGER John Balco PIC/AIC John Balco
HEALTH & SAFETY PLAN PREPARED BY Sara Hanna DATE 4/11/89
_____"_____
_____"_____
HEALTH & SAFETY PLAN APPROVED BY * DATE _____
_____"_____

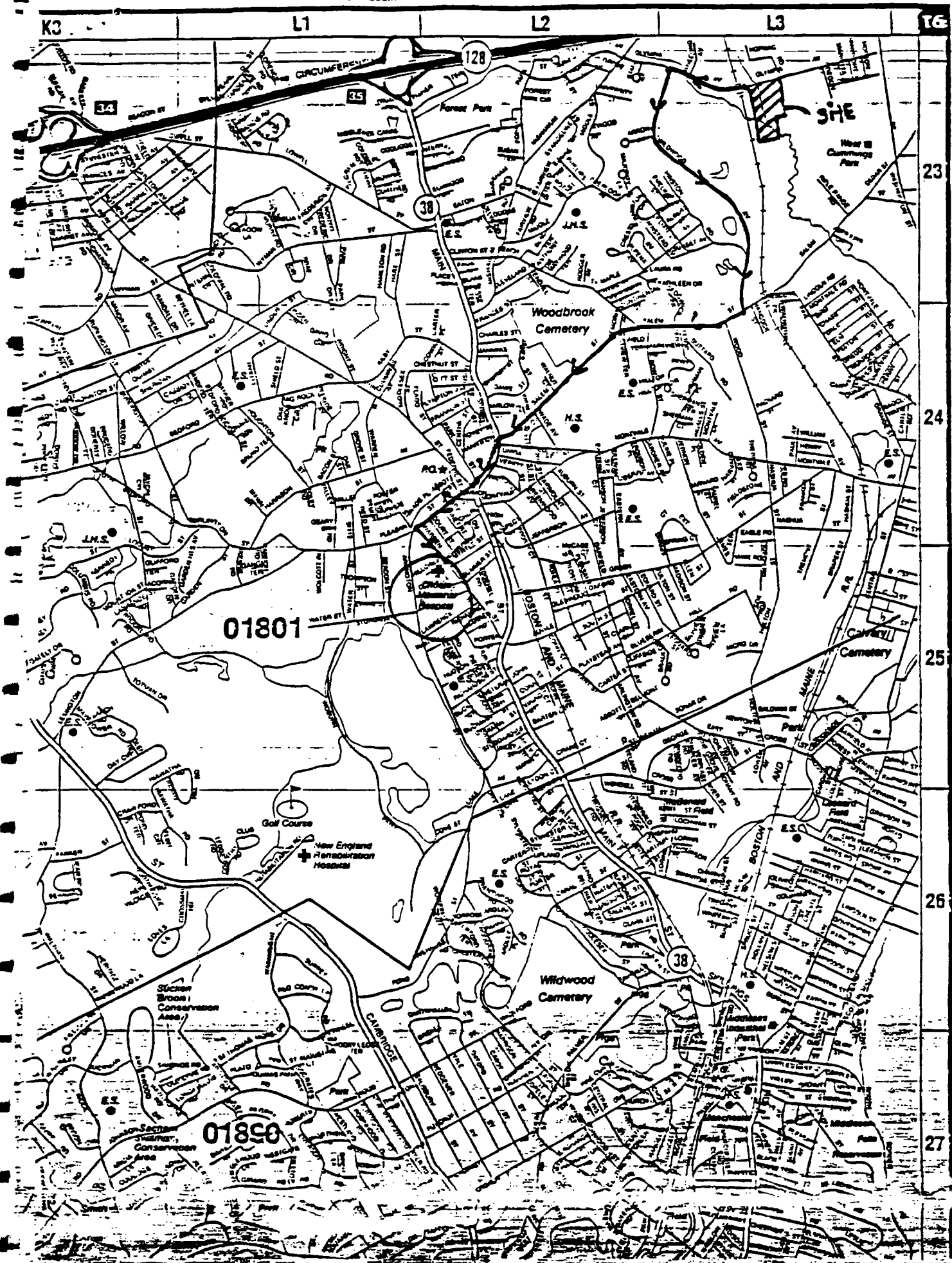
* Plan will be submitted for G24 approver's signature following notification of Digsafe.

Goldberg-Zoino & Associates, Inc.

READY-BAG CHECKLIST

- _____ 1. MSA Ultratwin full-face air-purifying respirator, in a protective plastic bag.
- _____ 2. Nose-cup insert for MSA Ultratwin respirator.
- _____ 3. MSA ear-muff set which fits into hardhat or earplugs.
- _____ 4. Optional: Eyeglass kit for MSA Ultratwin respirator.
- _____ 5. MSA cartridges for respirator, type GMC-W, color-coded yellow and magenta.
- _____ 6. Protective lense cover for MSA Ultratwin respirator.
- _____ 7. Hardhat
- _____ 8. Latex gloves.
- _____ 9. Nitrile gloves.
- _____ 10. Poly-laminated Tyvek suit.
- _____ 11. Safety glasses.
- _____ 12. Plastic disposal bag.
- _____ 13. Outer Rubber Boots.
- _____ 14. NIOSH Pocket Guide To Chemical Hazards.
- _____ 15. Eyewash Bottle.

Note: The equipment listed above comprises the standard GZA "Ready Bag", and will provide appropriate protection from chemical exposure and noise in most situations encountered. However, for a particular job, certain items which are not included in the standard ready bag may be required, for example, a different type of coverall or respirator cartridge. Therefore, the Site-Specific Health and Safety Plan should always be consulted to make sure the proper equipment is brought to the site.





DANIEL S. GREENBAUM
Commissioner
935-2160

The Commonwealth of Massachusetts
Department of Environmental Quality Engineering
Metropolitan Boston - Northeast Region
5.1 Commonwealth Avenue
Woburn, Massachusetts 01801

May 9, 1989

Mr. John Balco
Goldberg Zoino & Associates, Inc.
320 Needham Street
Newton Upper Falls, MA 02164

RE: WOBURN-60 Olympia Avenue
Phase II Scope of Work
DEQE Case No. 3-594

Dear Mr. Balco:

The Department of Environmental Quality Engineering has reviewed the proposed Scope of Work for the Phase II site investigation of the 60 Olympia Avenue property dated April 14, 1989. The Phase II investigation is designed to focus on the petroleum contamination in and around the underground storage tank area and the fuel pump islands. The field exploration includes a soil gas survey, installation of 5 to 10 shallow wells and 2 deep wells, screening of soil and groundwater samples for volatile organic compounds and analysis of selected soil and groundwater samples for total petroleum hydrocarbons and oil fingerprinting.

Before final approval can be granted for the Phase II work plan, the Department wishes to clarify the following items.

1. A description of the procedure that will be used to conduct the soil gas survey must be provided to the Department for review.
2. The Department considers 2 inch diameter monitoring wells to be standard protocol and requests that they be installed at this site.
3. The results of the soil gas survey and proposed boring locations based on those results should be reviewed by the Department prior to implementing the drilling program.
4. The proposed analytical parameters and methods are inappropriate for a Phase II investigation of the site. Screening analyses are useful in achieving areal coverage of a large area such as would be accomplished in the soil gas survey. It is of limited utility, however, when defining the contaminant profile of the site. Given the potential presence of gasoline, diesel fuel and chlorinated solvent contamination, a soil and groundwater sample from each monitoring location, i.e. boring, monitoring well, must be analyzed for volatile organic compounds using EPA Method 8240.

Page 2

5. When conducting the site risk characterization, exposure points must be identified based on current and reasonably foreseeable future use. Be advised that a reasonable foreseeable use of groundwater at the site is as a source of drinking water since it is within the area of influence of Woburn's Municipal Wells G & H.

Once an addendum addressing these issues has been submitted to the Department, approval for the Phase II investigation will be granted. If you have any questions regarding this matter, please contact Rodene DeRice at the letterhead address or phone 935-2160.

Very truly yours,

Rodene A. DeRice

Rodene A. DeRice
Environmental Analyst

Richard J. Chalpin

Richard J. Chalpin
Deputy Regional
Environmental Engineer

RJC/RAD/ram

cc: DEQE/DHW, 1 Winter St., Boston, MA 02108
BOH, 33 Plympton St., Woburn, MA 01801
Mr. Charles Whitten, Olympia Nominee Trust, 39 Holton St., Winchester, MA 01890



GOLDBERG·ZOINO & ASSOCIATES, INC.

The VECO Building 320 Needham Street Newton Upper Falls, MA 02464
617-969-0050 FAX 617-965-7762

June 5, 1989
File No. 2-4596.2-C, PC
2-4596-C

Ms. Rodene DeRice
Massachusetts Department of
Environmental Quality Engineering
5A Commonwealth Avenue
Woburn, Massachusetts 01801

Re: Addendum to Proposed
Phase II Scope of Work
60 Olympia Avenue
Woburn, Massachusetts
DEQE Case No. 3-594

Dear Ms. DeRice:

In response to your letter on May 9, 1989, Goldberg-Zoino & Associates, Inc. (GZA) is submitting this addendum to our proposed Phase II Scope of Work for the above referenced site, which was submitted to the Department of Environmental Quality Engineering on April 14, 1989. GZA is undertaking this work on behalf of our Client, Juniper Development Group, Inc.

GZA agrees to the five items listed in the May 9, 1989 letter, as specifically addressed below:

1. A description of the proposed soil gas monitoring procedure is attached for the Department's review.
2. Observation wells to be installed during the Phase II assessment will be 2 inches in diameter. Note that several of the previously installed wells at the site are 1-1/2 inches in diameter.
3. GZA will submit a brief letter describing the results of the soil gas monitoring program, together with a sketch or drawing showing proposed boring locations, to the Department for review following completion of the soil gas program but prior to the execution of borings.

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Massachusetts Department of Environmental Quality Engineering
June 5, 1989 - File No. 2-4596.2 - Page 2


4. GZA will analyze a soil sample from each boring location for volatile organic compounds (VOCs) using EPA Method 8240. Soil samples will be selected for quantitative analysis based on the results of screening using an H-Nu photoionization detector. A groundwater sample from each well will be analyzed for VOCs using EPA Method 524.
5. The site risk characterization will consider an evaluation of potential use of groundwater as a drinking water source. Note that drinking water VOC analyses will be conducted on the groundwater samples, as stated in Item 4 above.

GZA trusts that this addendum to the proposed Phase II Scope of Work addresses the Department's concerns. We are prepared to begin the soil gas monitoring phase of the project upon receipt of your comments on the proposed soil gas monitoring procedures. Should you have additional questions or comments, please contact the undersigned at (617) 969-0050, extension 157 (S. Hanna) or extension 267 (J. Balco).

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.


Sara R. Hanna
Senior Project Manager


John J. Balco
Associate-in-Charge

SRH/JJB:bnt

Attachment: Soil Gas Monitoring Procedures

cc: Mr. Charles Whitten, Juniper Development Group, Inc.



SOIL GAS MONITORING

Soil gas monitoring refers to the investigation of vapors within the pore space of the unsaturated zone. These vapors can be analyzed in-situ for volatile organic compounds to help establish the extent of the plume, to find sources of contamination and to determine the effectiveness of remedial measures such as soil venting.

Soil gas investigations are fast and inexpensive as compared to conventional borings and monitoring wells. GZA typically samples and analyzes between 15 and 20 soil gas points per day. Using state-of-the-art portable analytic instrumentation, we can detect levels of VOC contamination down to the low part per billion range and we use this data to help determine the location of the next sampling point.

GZA obtains soil gas samples by driving a 4-foot stainless steel probe into the soil with a handheld slide weight or an electric vibratory hammer. Samples are taken at a depth of three to six feet. For the samples taken below impermeable surfaces, such as asphalt, the a 1/2 inch hole is first drilled with the electric vibratory hammer.

After a probe is inserted into the soil, it is then lifted several inches and a solid rod is inserted into the probe to eject a hardened tip. A three way valve sampling head is then attached to the probe. This three-way valve allows GC sampling directly into a luer lok syringe. During soil gas sampling the pump effluent is monitored with a photoionization detector and a GC sample is taken at a stable maximum. The probe is then removed from the soil and decontaminated.

GZA's combination of field experience, analytic chemistry skills and geo-hydrological expertise has allowed us to take full advantage of this new technology.

SOIL GAS MONITORING

SOP NO. 4.5

1. Purpose

Soil gas surveys are used as a rapid preliminary assessment technique for volatile organic compounds (VOC's). More specific objectives are as follows:

- A. Identifying potential sources of VOC's
- B. Deliniating the extent of groundwater contamination
- C. Evaluating the effectiveness of remedial measures ,such as soil venting
- D. Providing data about locations that may be inaccessible to other subsurface exploration techniques

2. Equipment and Materials

- Photovac model 10S10 portable gas chromatograph (GC) equipped with a cpsil-5 capillary column , an isothermal oven, a photoionization detector and GC accessories

or

- Foxboro model OVA-128 portable gas chromatograph (GC) equipped with a T-12 column, a flame ionization detector and GC accessories

Accessories include: External battery, 500 ml. glass bulb, extra GC columns, septa, manuals, 500 ul gas tight syringes, flow meter, ect.

- Data collection system

- A) Portable personal computer equipped with an analog to digital converter and Nelson Analytical Chromatograph Software

or

- B) Hewlett Packard 3390 reporting integrator

- Kango 950 rotary vibratory hammer and accessories:

Accessories include: 16-1/2" long spiral carbide hex-shank bit, 28-1/2" long spiral carbide hex-shank bit and hex drill adapter-driving head

- Gasoline powered electrical generator capable of powering the rotary vibratory hammer



- Total organic vapor analyzer
 - 1) Hnu model PI-101 Photoionization Analyzer
 - 2) Photovac tip II
- Heavy duty extension cord- at least 200 ft.
- 5-10 soil gas probes
- Probe jack
- 2 sampling pumps (1 liter/min.)
- 1 low flow sampling pump
- Decontamination supplies
- Solid sorbant tubes
- 1/4" TFE tubing
- Tygon tubing
- Hardened tips
- Sampling head with three way valve
- 3/16" diameter solid stainless steel rod

3. Sampling procedures

- A) Assemble the sampling apparatus. Use the 1/4" TFE tubing to attach the sampling head to the sampling pump and the connect the output of the sampling pump to the total organic vapor analyzer.
- B) If necessary, drill through the impermiabile surface (i.e., concrete or asphalt) using the spiral carbide hex shank bit.
- C) Wrap the hardened tip with teflon tape to improve the seal and insert the tip into the bottom of the 4 ft. probe.
- D) Insert the 4 ft. probe into the soil with the vibratory hammer. If the probe is obstructed remove the probe and re-insert it. Do not force the probe around obstructions. Insert the probe 3 feet into the soil leaving 1 foot above the surface.
- E) Jack the probe up 6 inches.
- F) Expell the hardened tip by inserting the 3/16" diameter rod into the probe.
- G) Examine the top of the probe for deformations. Debur the probe, if necessary.
- H) Start the pump and the organic vapor analyzer. Make note of the background reading.
- I) Attach the sampling apparatus to the probe.
- J) Continously monitor the pump effluent for total VOC's until a stable maximum is observed. Switch the three way valve on the sampling head to the off position, disconnect the pump from the sampling head and record the maximum level of total VOC's.
- K) If no reading (above background) is observed for total VOC's than pump approximately 2 liters of soil gas before sampling.
- L) Obtain a sample for gas chromatography from the probe via the three way valve and direct luer-lok coupled syringe.
- M) Remove the probe and decontaminate it by rinsing thoroughly with distilled water.



- N) Pump air through the remaining sampling apparatus for at least 1 minute after sampling.

4. Three dimensional soil gas sampling (optional)

- A) Sample at a 3 foot depth as described above.
- B) Drill adjacent soil boring with the 28-1/2" spiral carbide hex shank bit. Drill the hole the full length of the bit.
- C) Wrap the hardened tip with teflon tape and insert the tip into the bottom of a 7 foot probe.
- D) Place the probe in the predrilled hole and drive the probe to a depth of 6 feet.
- E) Continue the sampling procedure as described in part 3, sections E through N.

5. Soil gas sampling with solid sorbants (optional)

- A) See S.O.P. 3.1.10 entitled "Ambient Air Sampling with Solid Sorbants" for a more detailed description of sorbent tube properties and procedures.
- B) Insert the probe and sample for total VOC's as described in part 3, sections A through K
- C) Attach the low flow sampling pump to the sampling head and attach the sorbent tube to the pump exit.
- D) Record the initial time and begin sampling
- E) Measure the flow rate of air exiting the sampling tube.
- F) Sample for a specified period of time based on the specific tube and the manufacturers suggested sample volume.
- G) Re-sample for total VOC's after the sampling period.

6. Gas Chromatography

- A. See SOP 4.1.1 entitled "Field Monitoring - OVA-128" for detailed operating procedures for the Foxboro portable organic vapor analyzer.
- B. See SOP 4.1.10 entitled "Field Monitoring - Photovac portable gas chromatograph" for detailed operating procedures for the photovac model 10S10.
- C. The standard operating procedures mentioned above describe the analysis of soil and water samples. The analysis of soil vapors differs from the analysis of soil and water in the manner in which the instrument is calibrated. Standards are prepared by injecting a known volume of the compound of interest into a glass bulb. The compound is allowed to totally evaporate and then a subsample of the known air standard is injected into the gas chromatograph.

7. Special Notes

- A. Concentration levels in the soil vapors depends on such factors as the volatility of the contaminants, weather

conditions, depth to groundwater and the geological profile of the site. These factors must be considered in order to properly interpret the data. For further information refer to GZA's technical guidance document on soil gas monitoring and the references listed in section 8.

- B. For a given site, it is good practice to install 50% to 75% of the soil gas monitoring points on a uniform grid pattern to avoid biasing the data. The remaining points should be located to provide greater data resolution in the areas that may be most important.
- C. Soil vapors "collect" beneath impermeable surfaces such as concrete and asphalt. These locations should be emphasized in a soil gas survey.
- D. Soil gas monitoring should be viewed as a rapid remote sensing technique. Accordingly, soil gas monitoring should always be confirmed with the installation of monitoring wells and by subsequent analysis of the resulting soil and water samples.

8. References

H.B. Kerfoot and L.J. Barrows, "Soil-Gas Measurement for Detection of Subsurface Organic Contamination", Environmental Monitoring Systems Office of the U.S. Environmental Protection Agency, Las Vegas Nevada,

E.G. Lappala and G.M. Thompson, "Detection of Groundwater Contamination by Shallow Gas Sampling in the Vadose Zone, Theory and Applications", Proceedings of the NWWA Conference on Vadose Zone Monitoring- NWWA, Las Vegas, NV 1983

G.M. Thompson and D.L. Marrin "Soil Gas Contamination Investigations : A Dynamic Approach" GWMR, p.88, Summer 1987.



GOLDBERG-ZOINO & ASSOCIATES, INC.
CONSULTING ENGINEERS, GEOLOGISTS, ENVIRONMENTAL SCIENTISTS

The GEO Building 320 Needham Street Newton Upper Falls, MA 02164
617/969-0050 FAX 617/965-7769

June 2, 1989
File No. 2-4596.2-C/PC

Mr. Charles Whitten
Juniper Development Group
39 Holton Street
Winchester, Massachusetts 01890

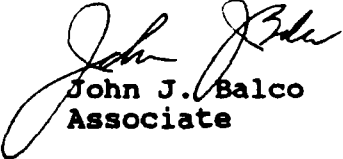
Re: Phase II Site Investigation
60 Olympia Avenue
Woburn, Massachusetts

Dear Mr. Whitten:

As per our discussion, Goldberg-Zoino & Associates will begin implementation of a Phase II Site Investigation for the 60 Olympia Avenue site. The cost estimate for the scope of work is attached. The Terms and Conditions of our February 19, 1988 proposal will also apply to this additional work.

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.


John J. Balco
Associate

JJB:crp
Attachment

File No. 2-4596.2
June 2, 1989

60 OLYMPIA AVENUE
PHASE II SITE INVESTIGATION BUDGET ESTIMATE

SOIL GAS SURVEY (30-40 Points)	\$5,000 - 8,000
DRILLING (Assumes 6-10 shallow, 2 deep wells; 4-5 days; 2" wells). May be reduced based on soil gas survey results.	\$11,500 - 13,500
SURVEYING, SAMPLING AND ANALYTICAL (Assumes 20-25 wells, 2 surface water; 1 soil (from new borings) and 1 groundwater per well for 8240/524 per DEQE; 5 PHCs, 10 TPHs). Not currently proposing GZA screening of water, (screening would add \approx 2-2.5K) and QA/QC \approx 10% of analytical.	\$13,000 - 16,000
ENVIRONMENTAL RISK ASSESSMENT	\$2,000 - 3,000
PUBLIC HEALTH RISK ASSESSMENT	\$15,000 - 20,000
REPORT	<u>\$7,000 - 10,000</u>
	\$53,500 - \$70,500



DANIEL S. GREENBAUM
Commissioner
935-2160

The Commonwealth of Massachusetts
Department of Environmental Quality Engineering
Metropolitan Boston - Northeast Region
5 Commonwealth Avenue
Woburn, Massachusetts 01801

June 26, 1989

Mr. John Balco
Goldberg Zoino & Associates, Inc.
320 Needham Street
Newton Upper Falls, MA 02164

RE: WOBURN-60 Olympia Avenue
Approval of Phase II Scope of Work
DEQE Case No. 3-594

Dear Mr. Balco:

The Department of Environmental Quality Engineering is in receipt of the addendum to the proposed Phase II Scope of Work for the 60 Olympia Avenue site. This addendum addresses the issues raised in a Department correspondence dated May 9, 1989.

The purpose of this letter is to formally notify you of the Department's approval of the Scope of Work dated April 14, 1989, including the addendum dated June 5, 1989.

Please notify Rodene DeRice of this office as to when the field investigation will commence. If you have any questions regarding this matter, please contact Rodene DeRice at the letterhead or phone 935-2160.

Very truly yours,

Rodene A. DeRice
Rodene DeRice
Environmental Analyst

Richard J. Chalpin
Richard J. Chalpin
Regional Engineer

RJC/RD/ram

cc: DEQE Site Assessment 5th Fl., 1 Winter St., Boston, MA 02108
BOH, 33 Plympton St., Woburn, MA 01801
Mr. Charles Whitten, Olympia Nominee Trust, 39 Holton St., Winchester, MA 01890



935-2160
Daniel S. Greenbaum
Commissioner

The Commonwealth of Massachusetts

Department of Environmental Quality Engineering

Metropolitan Boston - Northeast Region

5 Commonwealth Avenue

Woburn, Massachusetts 01801

NOV 20 1989

November 17, 1989

Ms. Sara Hanna
Goldberg Zoino & Associates, Inc.
The Geo Building
120 Needham Street
Newton Upper Falls, MA 02164

RE: WOBURN - 60 Olympia Avenue
DEP Case No. 3-594

Dear Ms. Hanna:

The Department of Environmental Protection is in receipt of the results of a soil gas survey conducted at the subject site and presented in a letter dated October 18, 1989.

Although the focus of the soil gas survey was the area of the petroleum underground storage tanks, the chlorinated organic compounds trichloroethylene and tetrachloroethylene were detected at nearly all of the monitoring points.

The proposed boring locations south of the underground tank areas will provide data indicating the extent of contamination by petroleum-related compounds as well as chlorinated organic compounds. Therefore, the Department approves the proposed boring program and looks forward to the implementation of this next phase of work.

Additional investigatory work may be needed in the future, however, to fully define the extent of chlorinated VOC contamination.

Very truly yours,

Rodene A. DeRice

Rodene A. DeRice
Environmental Analyst

R. J. Chalpin

Richard J. Chalpin
Regional Engineer

RJC/RAD/ram

cc: Mr. Charles Whitten, Juniper Devel. Group, 39 Holton St., Winchester, MA 01890
DEP/BWSC, 5th Floor, 1 Winter St., Boston, MA 02108
BOH, 33 Plympton St., Woburn, MA 01801

**PHASE II RISK CHARACTERIZATION
SCOPE OF WORK
60 OLYMPIA AVENUE
WOBURN, MASSACHUSETTS**

**Prepared for:
Juniper Development Group
Winchester, Massachusetts**

**Prepared by:
Goldberg-Zoino & Associates, Inc.
Newton Upper Falls, Massachusetts**

**May 1990
File No. 4596.2**



GOLDBERG-ZOINO & ASSOCIATES, INC.

100 NORTH STREET, NINTH FLOOR, NEW YORK, N.Y. 10038
(212) 691-1000

May 25, 1990
File No. 4596.2-C, PC
4596-C

Mr. Charles Whitten
Juniper Development Group
38 Holton Street
Winchester, Massachusetts 01890

Re: Phase II Risk Characterization
Scope of Work
60 Olympia Avenue
Woburn, Massachusetts
DEP Case No. 3-594

Dear Mr. Whitten:

Attached please find a proposed Scope of Work for a Phase II Risk Characterization at the above-referenced site. The Phase II Risk Characterization is part of Goldberg-Zoino & Associates, Inc.'s (GZA) ongoing Phase II study of the 60 Olympia Avenue site; a separate scope of work for the risk characterization portion of the Phase II study was required by the Massachusetts Department of Environmental Protection (DEP).

We appreciate the opportunity to assist you with this project. Please contact the undersigned should you have any questions regarding the scope of work or require further assistance.

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.

Sara R. Hanna
Senior Technical Specialist

John J. Balco
Associate

SRH/JJB:bsr
Attachment: Report



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TABLE NO. 8	USEPA AMBIENT WATER QUALITY CRITERIA FOR SURFACE WATERS



1.00 INTRODUCTION

The following document presents a proposed scope of work for a Phase II Risk Characterization at the 60 Olympia Avenue (Olympia Nominee Trust) site in Woburn, Massachusetts. The scope of work has been developed by Goldberg-Zoino & Associates, Inc. (GZA) on behalf of our client, Juniper Development, Inc. The Phase II study is being conducted in accordance with a work plan dated April 14, 1989, as amended by subsequent correspondence with the Massachusetts Department of Environmental Protection (DEP) to assess the impacts of petroleum contamination related to underground storage tanks currently or formerly located on the portion of the property east of the Aberjona River.

1.10 REGULATORY FRAMEWORK

The Massachusetts Contingency Plan (MCP) requires that a public health and environmental risk characterization be completed as part of a Phase II Study (310 CMR 40.545(g) and (h)). The risk characterization will be completed in accordance with the requirements for Phase II assessments under the MCP, as outlined in 310 CMR 40.545(g) and (h), and DEP guidance for meeting these requirements (DEP, May 9, 1989). There is no specific DEP guidance available for ecological risk characterizations.

To comply with these requirements, a public health and environmental risk characterization will be completed to evaluate the level of human health and ecological risk associated with exposures to oil and hazardous material (OHM) under current and reasonably foreseeable future uses of the 60 Olympia Avenue site. Workers at the facility that may be exposed to constituents associated with oil and gasoline at the site or these constituents that have migrated from the site to the Aberjona River and the area potentially supplying Wells G and H will be evaluated.

As part of our Phase II study, DEP, Northeast Region, requested that a Phase II Risk Characterization Scope of Work be submitted prior to the commencement of the risk characterization work. The following scope of work is based upon the draft DEP document "Suggested Outline, Content and Format of Phase II Risk Characterization Scope of Work."

As stated in the DEP letter of May 9, 1989, prepared by Ms. Rodene A. DeRice and Mr. Richard J. Chaplin, as well as subsequent telephone conversations, DEP considers that a foreseeable future use of groundwater migrating from the site is as a source of drinking water, as it is within the area of influence



of Woburn's Municipal Wells G and H. These two wells were closed in 1979, following identification of petroleum and chlorinated solvents in the groundwater attributed to a regional contamination problem, and have remained closed since that time.

Conversations with Mr. William Neiman of the City of Woburn Department of Public Works indicate that the groundwater in the vicinity of the site is not used for any purpose, as all homes, commercial, and industrial facilities are connected to either the Ray Roc Supply (Horn Pond Valley) or to the public (MWRA) supply with a remote reservoir source. Water usage patterns will be confirmed in the Phase II Site Investigation Report.

1.20 SITE BACKGROUND

To date, a number of studies have been performed at the Wells G and H Superfund site, which include the property at 60 Olympia Avenue. Previous studies performed by Alliance Technologies Corporation (1986) and Ebasco Services, Inc. (1988) identified both petroleum constituents and chlorinated volatile organic compounds (VOCs) contamination in various media at the site. The Ebasco Services, Inc. (1988) report discussed contamination present on the Wells G and H Superfund site, inclusive of the five "potentially responsible parties" (PRPs) properties (Olympia Nominee Trust Company - the study site, Unifirst Corporation, W.R. Grace Corporation, New England Plastics Corporation and Wildwood Conservation Corporation). The Ebasco report identified potential exposure pathways and receptors, and performed quantitative risk characterizations for each property. The report prepared by Alliance Technologies Corporation (1986) included a wetlands endangerment assessment for the entire Wells G and H site.

Both of these studies, as well as the reports prepared by Goldberg-Zoino & Associates, Inc. (GZA, 1985; GZA, 1988; GZA, 1989), referenced on the attached list, indicate that the chlorinated VOCs contamination appears to be a regional problem. The effects of the chlorinated VOCs on both the public health and the environment have been addressed in the aforementioned Ebasco (1988) and Alliance (1986) reports, and therefore, this risk characterization will focus on the petroleum contaminants potentially associated with the 60 Olympia Avenue property (Table 1).

As presented in GZA reports, approximately 8 acres of the 60 Olympia Avenue site are paved and currently being used as a truck terminal. The site is owned by Juniper Development and is utilized by several tenants including United Truck Leasing Inc. and RPS Trucking. It is likely that future use of the site will remain as industrial. Remaining portions of this 21-acre site are primarily vegetated wetlands along the Aberjona River. The area north of the site across Olympia Avenue is occupied by both light manufacturing and commercial facilities. Although the 60 Olympia Avenue property includes land to the west of the Aberjona River,



the property covered by the present study is bounded to the west by the Aberjona River and associated wetlands. The site is bounded to the south by the wetlands, and to the east by undeveloped forest land, which is zoned as an "office park" area by the Woburn Engineering Department and Assessor's Office. Because of restriction on wetlands development under federal and state statutes, it is likely this portion of the property will remain wetlands.

Compounds which are associated with petroleum contamination have been detected in groundwater samples, in surface water samples from the Aberjona River, and in soil samples underneath the pavement (GZA, 1985; GZA, 1988; GZA, 1989; Hydell-Ester Technologies, 1987). Petroleum-associated aromatic volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, xylenes (BTEX), one polynuclear aromatic hydrocarbon (PAH) and alkylated benzenes have been detected in collected groundwater samples. These petroleum constituents are detected primarily in groundwater located in wells proximate to the source area. The source area includes the areas surrounding the abandoned gasoline fuel pump island, the currently operating diesel fuel pump, and the general area in which underground petroleum fuel storage tanks are located. The highest concentrations of the petroleum-associated compounds were detected at Well MW-1. A summary of the most recent groundwater data is provided in Table 2.

Low levels of BTEX and gasoline additive methyl-t-butylether have been detected in soil from four boring locations. These four boring locations (GZ-1, GZ-3, GZ-4 and GZ-11) are located in the vicinity of the source area. Soil samples collected from well location GZ-1 in the S-3 zone appeared to have the highest concentrations of these petroleum constituents (Table 3).

Additionally, soil gas levels were monitored in 29 locations at the site. Low concentrations of BTEX compounds were detected in fewer than half of the locations; the locations which had detectable quantities of soil gas (BTEX) were generally proximate to the source area of the site. A summary of this soil gas data is provided in Table 4.

Surface water data from samples collected from the Aberjona River indicate that the levels of petroleum constituents are essentially the same upstream of the site as downstream.

For the purposes of this risk characterization, the site is defined as the paved area upon which the facility is located; being east of the Aberjona River, and surrounding areas to which contaminated groundwater might reasonably be expected to migrate. The evaluation of soil contamination will focus on the petroleum contamination in the vicinity of the underground storage tank area and fuel pump islands. The groundwater from the site generally flows in a southwesterly direction; however, variability has been



observed in the collected data. The potential receptors of groundwater discharge have been identified as the Aberjona River, and the wetlands surrounding the site and the area potentially supplying Wells G and H.

2.00 PUBLIC HEALTH RISK CHARACTERIZATION

2.10 HAZARD IDENTIFICATION

The purpose of the hazard identification is to identify the nature and extent of release of petroleum associated compounds identified at the 60 Olympia Avenue site and to provide toxicity information on the detected compounds. The compounds to be evaluated in the public health risk characterization are presented in Table 1.

The extent of release of these compounds detected at the site as representative of current conditions at the site has been discussed in Section 1.20. In addition to current extent of contamination, site information related to potential future migration of groundwater to off-site receptor locations, including groundwater flow direction toward Wells G and H, and discharge to the wetlands and the Aberjona River will be further defined. Based on preliminary review of available information, most of the contaminated groundwater is likely to discharge into the Aberjona River at the northwest portion of the site. Concentrations are likely to be significantly diluted by surface water and groundwater recharge.

Toxicity profiles will be prepared for each of the compounds addressed in this risk assessment.

2.20 DOSE-RESPONSE ASSESSMENT

2.21 Identification of Toxicity Values

The dose-response assessment describes the observed effects of OHM in humans and/or laboratory animals. Dose-response information is compiled for each OHM evaluated in the risk assessment. EPA Reference Doses (RfDs) or DEP Allowable Threshold Concentrations (ATCs) are used for evaluation of potential non-carcinogenic (threshold) effects. EPA Carcinogenic Potency Factors (CPFs) are used for evaluation of potential carcinogenic (non-threshold) effects.

The RfD represents a human intake level of a chemical, expressed in mg/kg/day, that is not likely to cause adverse effects when exposure is long term (lifetime). The RfD is usually based on chronic animal studies. RfDs are developed by a USEPA inter-office work group chaired by the Office of Research and Development.



The ATC is a concentration of the OHM in air which would not be expected to result in adverse non-carcinogenic health effects. ATCs are derived by DEP from the Threshold Effects Exposure Limits (TELEs) using exposure assumptions for children as the most sensitive potential receptors. Acceptable daily doses are derived from ATCs and standard exposure assumptions, including inhalation rates and body weight.

CPFs are used for the evaluation of exposures to potential carcinogens. CPFs are derived by the USEPA's Carcinogen Assessment Group (CAG). CPFs are derived as the upper 95 percent confidence limits on the slope of the dose-response curve. These values are used to estimate potential carcinogenic risk per unit of exposure over a lifetime. CPFs are expressed in units of (mg/kg/day)⁻¹.

The EPA has provided RfDs and CPFs for exposures through the routes of ingestion and inhalation. These toxicity values are obtained from the USEPA's Integrated Risk Information System (IRIS) (USEPA, 1990) or from the USEPA Health Effects Assessment Summary Tables, when not listed in IRIS (USEPA, October 1989). ATCs are obtained from DEP guidance when inhalation RfDs are not available from EPA (DEP, May 1989). The target organ or health effect associated with exposure and EPA's weight of evidence classification for potential carcinogenicity are also provided for each OHM. A preliminary table of toxicity values for the petroleum associated constituents identified at the site is attached (Table 5).

Since toxicity values are not available for the alkylated benzenes, the potential toxicity associated with exposure to these compounds will be qualitatively discussed.

2.22 Identification of Public Health Standards

The MCP requires that applicable or suitably analogous public health standards, guidelines, and policies be identified for compounds detected in groundwater and surface water. These criteria are not available for soils and sediment. Table 6 summarizes the applicable groundwater standards and guidelines for petroleum associated compounds identified at the site. Clean-up levels are not currently available from DEP for any media.

2.30 EXPOSURE ASSESSMENT

In the exposure assessment, the mechanisms by which chemicals may reach human receptors under current and reasonably foreseeable future uses of the site will be evaluated. To complete the exposure assessment, migration pathways and potential human receptors will be identified; potential exposure points and routes will be determined; and exposure point concentrations will be identified or estimated, as appropriate. Average daily doses will be estimated based on conservative exposure assumptions and factors



in accordance with state and federal guidance. We reviewed current and potential exposure pathways to site contaminants, and described them below. In addition, the potential exposure pathways and receptors are summarized in Table 7.

2.31 Identification of Potential Human Receptors, Exposure Points and Exposure Routes

On-Site Exposures

As described in Section 1.00, on-site exposures to OHM do not appear to be significant as the study site is paved (e.g., there is no access to soils) and groundwater is not used for either truck terminal operations or for drinking purposes.

Future exposures to OHM in on-site soils are limited to facility workers during theoretical construction activities involving excavation beneath pavement. On-site construction workers may come into direct contact with contaminated soils (dermal absorption and incidental ingestion) and from inhalation of volatilized contaminants released from the soils. As this industrial portion of the site is almost completely fenced and generally inaccessible to the public, the potential for exposure to trespassers during excavation activities is minimal.

Off-Site Exposures

Wells G and H

Exposures to petroleum constituents in groundwater which has migrated from the site to the area of Wells G and H are to be considered under reasonably foreseeable future conditions, as defined by the DEP. Although the site groundwater is not currently being used for drinking water, DEP considers that migrating site groundwater could be used for drinking water, as the site is located within the area of influence of Woburn's Municipal Wells G and H. Potential receptors include both adult and child residents in the vicinity who are serviced by Woburn Municipal Wells. Exposure pathways for these receptors include ingestion, dermal absorption and inhalation.

Aberjona River

The Aberjona River is a discharge area for the site groundwater. Exposures to this medium under future conditions will be assessed in the risk characterization.

The DEP's surface water classification (goal) for the Aberjona River is Class B. Based on this classification, the river is designated for the uses of protection and propagation of fish, other aquatic life and wildlife; and for primary and secondary recreation. The current river water quality does not



support (NS) this classification; water quality problems include elevated levels of ammonia, coliform bacteria, and metals, in addition to low dissolved oxygen (DEP, April 1989).

At the time of a GZA site visit on March 15, 1990, the river was observed to have relatively low flow and to contain significant quantities of debris. Refuse which had been discarded into the Aberjona River included tires, oil containers, aluminum cans, and paper products. Additionally, a makeshift "footbridge" had been erected approximately 2 feet above the level of the river.

Based on the current river conditions in the vicinity at the study site, it seems unlikely that residents would participate in formal recreational river activities. However, incidental contact with the river may occur. Potential receptors to the Aberjona River (surface water) include both adult and child residents who may incidentally contact (dermal absorption and incidental ingestion) surface water.

2.32 Identification of Exposure Point Concentrations

Whenever possible, actual monitoring data will be used to identify exposure point concentrations. Monitoring data from GZA's October 1988 Hydrogeological Assessment Report, and October 1989 Soil Gas Survey will be used to help identify soil exposure concentrations. Exposure point concentrations for inhalation exposures will be modelled using soil gas data and volatilization and dispersion models. Groundwater exposure point concentrations at Wells G and H and Aberjona River will be based on current site groundwater data and mass flux and dilution calculations.

2.33 Selection of Risk Characterization Method

The MCP describes four methods for site health risk characterization. The appropriate method is selected once potential receptors, exposure points, and exposure routes are identified, and it is known which OHMs are or are likely to be present at these exposure points.

The method described in 310 CMR 40.545 (3)(g) 3.b. (referred to as Method 3.b.) tentatively has been selected as the appropriate method for risk characterization of the 60 Olympia Avenue site. This selection is based on the potential transportation of the petroleum constituents at the site to exposure points through multiple media (soils, groundwater, air and surface water) and the absence of applicable or suitably analogous standards for each constituent detected in each medium.

2.34 Estimation of Average Daily Doses

As required by Method 3.b., Average Daily Doses (ADDs) for each OHM will be estimated for each receptor at each receptor point

via each applicable exposure route. ADDs represent the amount of OHM contacted and available for absorption into the body. ADDs will be calculated as the amount of OHM taken into the body per unit body weight per unit time (mg/kg/day). Chronic ADDs will be developed to evaluate exposure to non-carcinogenic compounds; lifetime ADDs will be estimated to evaluate exposure to carcinogenic compounds. ADDs will be estimated based on conservative exposure assumptions and factors developed in accordance with state and federal guidance (DEP, May 1989; USEPA, July 1989; USEPA, December 1989; and USEPA, Region 1, February 1989a).

2.35 Development of Exposure Profiles

Exposure profiles will be developed to describe each receptor and how that receptor may be exposed under current and/or reasonably foreseeable future site conditions. Future on-site construction workers may be exposed through direct contact to soils and associated volatilized contaminants on facility grounds. Residents from abutting properties may be potentially exposed to OHM in the future from migrated groundwater used as drinking water and through incidental contact with the Aberjona River.

2.40 RISK CHARACTERIZATION

2.41 Comparison with Public Health Standards

Exposure point concentrations of petroleum constituents will be compared to applicable or suitable analogous standards. Petroleum constituents with exposure point concentrations greater than the standards will be identified.

2.42 Evaluation of Non-Carcinogenic and Carcinogenic Risks

Exposures to OHM will be also be quantitatively evaluated using the toxicity values and the ADDs described in previous sections. Non-carcinogenic and carcinogenic effects will be assessed separately.

Non-Carcinogenic Effects

For each OHM, the estimated ADD will be divided by the appropriate RfD to yield a Hazard Index:

$$\text{Hazard Index} = \text{ADD}/\text{RfD}$$

The Hazard Index yields a general indication of whether exposures are likely to result in adverse health effects.

For multiple chemical exposures, single Hazard Indices are summed to yield a cumulative Hazard Index. This approach assumes an additivity of toxic effects by the same mechanism and

similar effects on target organs. Consequently, the application of this approach to a mixture of compounds that are not expected to induce the same type of effects could overestimate the potential for effects.

For each receptor a total site Hazard Index will be derived by summing the cumulative Hazard Indices for each applicable exposure pathway. This calculated total site Hazard Index will be compared to the total site non-cancer risk limit of 0.2 specified in the MCP. Total site Hazard Indices greater than the risk limit will be identified.

Carcinogenic Effects

Carcinogenic risks from exposure are expressed as probabilities. To assess incremental lifetime cancer risks from exposures to individual OHM, the lifetime ADDs will be multiplied by their respective CPFs to yield lifetime cancer risk estimates:

$$\text{Risk} = \text{ADD} \times \text{CPF}$$

For multiple chemical exposures, single OHM risk estimates for a specific exposure will be summed to yield a cumulative risk estimate. This summation assumes that individual intakes are small. It also assumes independence of action by the OHM involved (i.e., that there are no synergistic or antagonistic chemical interactions and that all chemicals have the same toxicological mechanism and endpoint).

For each receptor, a total site risk estimate will be derived by summing the cumulative risk estimates for each applicable exposure pathway. Calculated total site risk estimates will be compared to the total site risk limit of 1×10^{-5} specified in the MCP. This level represents a probability of one incremental cancer case per 100,000 people exposed.

3.00 ECOLOGICAL RISK CHARACTERIZATION

In addition to potential public health risks, the ecological community may also be affected by contamination associated with the 60 Olympia Avenue property. Chemicals present at the site or migrating off-site may be toxic to plants and animals exposed to these substances via the air, water, soil, sediment or food chain. This assessment will address ecological risks due to contaminants attributable to the 60 Olympia Avenue site. As described previously, risks due to chlorinated volatile organic compounds in the vicinity of the Wells G and H Superfund site have already been addressed by others (Alliance, 1987; Ebasco, 1988) and will not be addressed here. For the most part, the chlorinated compounds detected on site are associated with the Wells G and H Superfund



site. This study will focus on constituents of gasoline and diesel fuel formerly stored on the 60 Olympia Avenue property and presently detected in site soil and groundwater.

The proposed ecological risk assessment will identify possible environmental receptors; address the potential pathways by which these receptors may be exposed to the chemicals of potential concern from the site; and discuss the potential risks to terrestrial and aquatic wildlife that may exist in the wetlands and reach of the Aberjona River surrounding the site. As there are no ecological/environmental risk assessment guidelines in the MCP or in related DEP guidance documents, this ecological risk assessment will be conducted in accordance with USEPA ecological risk assessment procedures (USEPA, November 1988; USEPA, February 1989b; USEPA, March 1989a; and USEPA, March 1989b). The assessment will include comparison of estimated or detected surface water concentrations with any applicable or suitably analogous environmental standards, guidelines and policies such as USEPA Ambient Water Quality Criteria (AWQC) (USEPA, 1986). The assessment will also discuss the estimated contribution of the site contaminants to the contaminant load within the sediment of the Aberjona River. Presently there are no quality criteria available for sediment.

The Phase II ecological risk assessment will include:

1. Identification of contaminants of concern and contaminated environmental media, and the potential future extent of contaminant migration to surface waters, sediments, soils, and the biota associated with the 60 Olympia Avenue property, surrounding wetlands, and the Aberjona River;
2. Identification of potential biological receptors through field investigations and review of previous reports (Alliance, 1987; Ebasco 1988);
3. Selection of chemicals, species and assessment endpoints for risk assessment;
4. An exposure assessment;
5. Review of the toxicological literature; and
6. Risk characterization.

The data collected will be used to characterize the potential bioavailability and toxicity of contaminants to resident biological communities in wetlands surrounding the 60 Olympia Avenue site, and the Aberjona River. While the protection of individual environmental receptors may be important (e.g., the death of one individual of an endangered species), in most cases environmental risk assessments focus on the population level.



3.10 IDENTIFICATION OF CONTAMINANTS AND CONTAMINATED ENVIRONMENTAL MEDIA

The chemicals that will be evaluated in this ecological assessment are constituents of gasoline and diesel fuel. They will be selected based on their frequency of detection and concentration in site soil and groundwater, decomposition rates and products, bioaccumulation potential, toxicity and the physical and chemical properties which influence their environmental fate and transport. We anticipate that the compounds of concern will include aromatic volatile constituents of gasoline, and diesel fuel such as benzene, toluene, ethylbenzene and xylenes (BTEX); and polynuclear aromatic hydrocarbons (PAHs) (Table 1). Where information is available on specific petroleum products (gasoline or diesel fuel), we will assess the risks associated with these products. Table 8 lists the USEPA AWQC for the protection of freshwater aquatic life for the anticipated compounds of concern.

3.20 SITE CHARACTERIZATION AND IDENTIFICATION OF POTENTIAL BIOLOGICAL RECEPTORS

Extensive characterization of the environment of the Wells G and H site has been performed by others (Alliance, 1987; Ebasco, 1988). Alliance (1987) sampled the Aberjona River at various locations within the Wells G and H site for plankton, benthic organisms, and macrophytes as well as water quality parameters (dissolved oxygen and temperature). In addition, they characterized the major plant cover types and wildlife that might be present. The 1988 Ebasco report primarily drew on information in the 1987 Alliance report regarding characterization of the Wells G and H environment. We will base our site characterization on information found in these previous reports as well as other reference sources, and a field survey in the vicinity of the site.

This work will be conducted to identify "environmentally sensitive areas" as defined by the MCP. "Sensitive areas" include wetlands, areas subject to flooding and sensitive terrestrial/aquatic habitats which would include habitat of threatened, rare, or endangered species or species of special concern. In addition, we will gather information on the general physical and chemical characteristics of the Aberjona River; the occurrence of important terrestrial and aquatic animals; and any visible signs of contaminant and ecological effects.

An initial site visit has been conducted by GZA personnel and the following habitat features were noted. A channelized portion of the Aberjona River flows south along the western border of the 60 Olympia Avenue site. The river bank is lined with Red Maples (Acer rubrum) and European Buckthorn (Rhamnus frangula) shrubs. South and southwest of the site is an extensive area of shallow marsh dominated by Tussock Sedge (Carex stricta), Broad-leaved Cattail (Typha latifolia), Common Reed (Phragmites australis), and

Purple Loosestrife (Lythrum salicaria). East to southeast of the site is a red maple swamp with a diverse shrub layer of Highbush Blueberry (Vaccinium corymbosum), Swamp Azalea (Rhododendron viscosum), Swamp Dogwood (Cornus amomum), Withe-rod (Viburnum cassinoides), Arrow-wood (Viburnum recognitum), and European Buckthorn. Cinnamon Fern (Osmunda cinnamomea), Sensitive Fern (Onoclea sensibilis), Skunk Cabbage (Symplocarpus foetidus), and Sphagnum Moss (Sphagnum spp.) were abundant in the herb layer. Leachate containing a rust-colored precipitate was found in this swamp at the toe of the fenced property line slope.

According to the 1987 Alliance report, the 100-year floodplain of the Aberjona River near the site is between elevation 46 and 48 feet above Mean Sea Level. The 100-year flood extends around all but the northeasterly side of the property, an area of upland oak forest.

According to the Massachusetts Natural Heritage and Endangered Species Program, no state-listed rare wetlands wildlife habitat is present in the vicinity of the site. However, the Mystic Valley Amphipod (Crangonyx aberrans), a Massachusetts species of special concern, has been found in reaches of the Aberjona River north of Route 128. Douglas Smith, Curator of Invertebrates, Museum of Zoology, University of Massachusetts, first discovered this species of crustacean and believes that the organism could be found south of Route 128 in the vicinity of the site (Alliance, 1987). The amphipod is found in cool, shallow, slow moving water with leaf litter. Bordering vegetated wetlands in which water is usually present, provide the optimal habitat. An additional Massachusetts species of special concern that may also inhabit the wetland surrounding the 60 Olympia Avenue site is the Intricate Fairy Shrimp (Eubbranchipus intricatus) (Alliance, 1987).

In an additional field visit GZA will note any observed terrestrial wildlife or signs of wildlife in the vicinity of the site, dip net select areas to look for the presence of the Mystic Valley Amphipod and Intricate Fairy Shrimp, and conduct limited benthic and macrophyte sampling to compare with the previous findings of Alliance (1987).

If possible, a reference wetland area and upstream reach of the Aberjona River will be chosen for comparison with wetlands and portions of the river potentially exposed to contaminants from the 60 Olympia Avenue site. However, due to the urban nature of the area surrounding the site, it may not be possible to find a suitable reference area.

In either event, the field survey will provide an estimate of plant species coverage and dominance. Qualitative observations will be made of wildlife habitat features, wildlife signs or sightings and semi-quantitative information on benthic species will be noted. Additional information on wildlife will be obtained by consulting



the Massachusetts Fish and Wildlife Service, and the City of Woburn Conservation Commission. The Massachusetts Natural Heritage Program will be contacted regarding the presence of rare plants or animals or ecologically significant natural communities in the vicinity of the study area.

3.30 EXPOSURE ASSESSMENT

The sources of the contaminants have been discussed above. The release of contaminants from the 60 Olympia Avenue site may have resulted in soil, sediment and surface water contamination which could affect the biota living at or near the site.

The transport media addressed in this study will be groundwater and surface water. In particular, the impact of groundwater discharge from the site to the Aberjona River and associated wetlands will be evaluated.

The exposure assessment will identify exposure pathways and routes by which aquatic and possibly terrestrial organisms may be exposed to contaminants via the air, water, soil, bottom sediment, or the food chain. Potential faunal or floral indicator species will represent various trophic levels and functional ecological niches within each habitat. For example, indicator species within the Aberjona River may include a bottom dwelling scavenger, forage fish and aquatic macrophyte. We will develop profiles of life history and sensitive life stages for each species to the extent that such information exists. However, information concerning persistence and metabolism may be limited.

Groundwater flow information generated as part of this Phase II study will be used in conjunction with contaminant concentrations measured at the 60 Olympia Avenue property to predict contaminant loadings. These loadings, and morphological data for the Aberjona River will be used in an evaluative partitioning model developed by McKay and Patterson at the University of Toronto to calculate exposure point concentrations. This model predicts environmental concentrations in an aquatic ecosystem based on chemical and physical properties of the compound and environmental transport mechanisms. The model uses the concept of fugacity to link as many as five environmental compartments, air, water, sediment, suspended aquatic matter, and biota. The product of such a model is an evaluation of how a given chemical will partition in an environment of given characteristics.

3.40 TOXICOLOGICAL LITERATURE REVIEW AND ASSESSMENT

A literature review will be conducted to characterize the toxicity of the various contaminants of concern. We will summarize the literature, and where available, provide the USEPA AWQC and acute and chronic toxicological values for the indicator species. Where such data are unavailable, data for a phylogenetically or



ecologically similar species will be provided. The uncertainty introduced by using toxicological data from related species will be noted as appropriate.

From this literature review, a number of appropriate toxicological endpoints will be selected for each contaminant (e.g., USEPA AWQC, chronic toxicity, and LC_{50} - the concentration of a contaminant at which 50 percent of the population dies) for each indicator species. The toxicity to aquatic biota of the chemicals of potential concern in surface water can be assessed using USEPA AWQC where available. These criteria are developed to protect 95 percent of all aquatic species. Specific toxicological endpoints for indicator species in the Aberjona River will also be used for the toxicity assessment.

EPA is in the process of developing sediment quality criteria for the protection of aquatic life exposed to contaminants in sediment. In the absence of any approved criteria, sediment contaminant concentrations predicted by the model or reported previously by EPA will be discussed relative to effects levels documented in the toxicity literature. For terrestrial plants, phytotoxicity data will be compared against the concentration of contaminants of concern in the soil and sediment. For terrestrial animals, available toxicity data from laboratory studies will be compared to exposure data. Field or laboratory bioassays are not proposed at the present time.

3.50 RISK CHARACTERIZATION

Flora and fauna may be exposed to chemicals present at the 60 Olympia Avenue site, the surrounding wetlands, and the Aberjona River. The risk characterization will address the potential toxicity of the chemicals of potential concern and the selected indicator species.

The risk characterization will be performed by comparing the exposure point concentrations for various indicator species to appropriate toxicological endpoints.

4.00 SAFETY AND PUBLIC WELFARE RISK CHARACTERIZATION

The MCP also requires a characterization of risk of harm to safety and public welfare. DEP has issued little policy or guidance for this part of the risk characterization. The only safety and welfare issues that appear to be relevant to the site are potential fire and explosion danger associated with petroleum products and potential health and safety concerns to workers during potential excavation activities at the site.



5.00 LIMITATIONS AND ANALYSIS OF UNCERTAINTIES

The uncertainties and limitations in the risk characterization process will be identified and qualitatively discussed. Uncertainties that may be addressed include the adequacy of sampling plan, quality of analytical data, accuracy of modeling procedures, assumptions concerning the frequency, duration and magnitude of exposures, and the availability and accuracy of toxicity data.

The limitations of the risk characterization will be briefly described, including the conservativeness of the methodology and the use of the results to highlight potential source(s) of risk, rather than represent absolute estimates of health risk.

6.00 CONCLUSIONS

Conclusions will be drawn concerning the need for site remediation based on the requirements set forth in 310 CMR 40.545 (3)(i). Conditions that may warrant remediation include:

- an exposure point concentration exceeds an applicable or suitably analogous public health or environmental standard; or
- a total site Hazard Index is greater than 0.2 or a Total Site Cancer Risk is greater than 1×10^{-5} .



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- U.S. Environmental Protection Agency (USEPA), July 1989, Exposure Factors Handbook. Office of Health and Environmental Assessment. Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), October 1989, Health Effects Assessment Summary Tables (HEAST), Office of Health and Environmental Assessment. Cincinnati, Ohio. Fourth quarter.
- U.S. Environmental Protection Agency (USEPA), December 1989, Risk Assessment Guidance for Superfund - Volume 1 - Human Health Evaluation Manual (Part A). Interim Final Office of Emergency and Remedial Response. Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), April, May 1990, Integrated Risk Information System (IRIS). Chemical files.

TABLES

TABLE 1

COMPOUNDS TO BE EVALUATED IN PHASE II
RISK CHARACTERIZATION
60 OLYMPIA AVENUE SITE

Compounds

Benzene
N-Butylbenzene
Sec-Butylbenzene
Tert-Butylbenzene
Ethylbenzene
Isopropylbenzene
P-Isopropyltoluene
Methyl Tert Butyl Ether (MTBE)
Naphthalene
N-Propylbenzene
Toluene
1,2,4-Trimethlybenzene
1,3,5-Trimethylbenzene
O-Xylene
P&M Xylenes

16 Total Petroleum Hydrocarbons

TABLE 2

SUMMARY OF ANALYTICAL RESULTS
FROM 60 OLYMPIA AVENUE
GROUNDWATER DATA

COMPOUND	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATIONS (ug/l)	WELL ID. WITH HIGHEST CONCENTRATION (ug/l)	METHOD DETECTION LIMIT (ug/l)
Benzene	8 / 19	Trace, 287	B-2A	0.5
N-Butylbenzene	1 / 19	0.7	GZ-2	0.5
Sec-Butylbenzene	1 / 19	0.6	GZ-2	0.5
Tert-Butylbenzene	1 / 19	1.4	GZ-1 (dup.)	0.5
Ethylbenzene	2 / 19	Trace, 12.5	GZ-1 (dup.)	0.5
Isopropylbenzene	3 / 19	0.7, 2.7	GZ-1 (dup.)	0.5
P-Isopropyltoluene	1 / 19	0.7	GZ-1 (dup.)	0.5
Naphthalene	5 / 19	0.6, 4370	MW-1	0.5, 500
N-Propylbenzene	2 / 19	1.3, 5.8	GZ-1 (dup.)	0.5
Toluene	7 / 19	0.5, 5.3	B-4	0.5
1,2,4-Trimethylbenzene	2 / 19	14.0, 61.8	MW-2	0.5, 10
1,3,5-Trimethylbenzene	3 / 19	2.3, 3870	MW-1	0.5, 500
O-Xylenes	8 / 19	Trace, 1880	MW-1	0.5, 500
P&M-Xylenes	7 / 19	0.8, 840	MW-1	0.5, 500
Total Petr. Hydrocarbons:				
Method No. 418.1	0 / 7	ND	NA	2 mg/l
ASTM Method D3328	2 / 2	0.04, 0.26	GZ-5	0.01 mg/l

NOTES:

1. Data from samples collected by GZA on 1/90, except for wells MW-1 and MW-2, which were sampled on 3/26/90.
2. Samples collected on 1/90 were analyzed for Volatile Organic Compounds (VOC's) using EPA Method 524, which had a detection limit of 0.5 ug/l. Samples collected on 3/26/90 were analyzed for VOC's using EPA Method 524.2, which had a detection limit of 500 ug/l for Well MW-1, and 10 ug/l for MW-2.
3. NA = Not Applicable, ND = None Detected.

TABLE 3

SUMMARY OF ANALYTICAL RESULTS
FROM 60 OLYMPIA AVENUE
GC SCREENING, GC 8240 ANALYSIS FOR VOC's IN SOILS

COMPOUND	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATIONS (ug/g)	LOCATION WITH HIGHEST CONCENTRATION (ug/g)	METHOD DETECTION LIMIT (ug/g)
Benzene	1 / 8	.013	GZ-11;S-3	0.01
Ethylbenzene	1 / 8	0.18	GZ-1;S-3	0.01
Methyl-t-Butyl Ether	2 / 8	3.6,3.6	GZ-1&3;S-2&3	0.1
Toluene	1 / 8	1.4	GZ-1;S-3	0.01
M,P-Xylenes	1 / 8	0.08	GZ-1;S-3	0.01
O-Xylene	1 / 8	0.09	GZ-1;S-3	0.01

NOTES:

1. Data from samples collected by GZA on April 8, 1988 and January 1-4, 1990.
2. Samples collected on 4/88 were analyzed for Volatile Organic Compounds (VOC's) using the Gas Chromatography Screening Method; concentrations are measured in parts per million (ppm), ug/gram of wet soil.
3. Samples collected on 1/90 were analyzed by EPA Method 8240.
4. Only detected compounds are listed above.
5. NA = Not Applicable, ND = None Detected.

TABLE 4
SUMMARY OF ANALYTICAL RESULTS
FROM 60 OLYMPIA AVENUE
SOIL GAS MONITORING RESULTS

COMPOUND	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATIONS (ppm)	LOCATION WITH HIGHEST CONCENTRATION (ppm)	METHOD DETECTION LIMIT (ppm)
Benzene	8 / 29	Trace, 1.8	SG-2	0.02
Ethylbenzene	0 / 29	ND	NA	0.05
Toluene	9 / 29	1.5	SG-8	0.02
M,P-Xylenes	3 / 29	Trace, 1.6	SG-8	0.05
O-Xylene	4 / 29	Trace, 1.0	SG-8	0.05

NOTES:

1. Data from samples collected by GZA on July 13-14, 1989. All samples were collected from a soil depth of approximately 3 feet.
2. Samples were analyzed for Volatile Organic Compounds (VOCs) using a Photovac 10s10 Gas Chromatograph (GC) equipped with heated oven and with a CPSIL-5 capillary column. The concentrations were converted to units of parts per million (ppm) - volume/volume, assuming standard temperature and pressure.
3. NA = Not Applicable, ND = None Detected.

TABLE 5
SUMMARY OF DOSE-RESPONSE INFORMATION
FOR INGESTION EXPOSURE

COMPOUND	NONCARCINOGENIC EFFECTS			CARCINOGENIC EFFECTS	
	Subchronic RfD (mg/kg/day)	Chronic RfD (mg/kg/day)	HEALTH EFFECT(S) OF CONCERN	CPF (mg/kg/day) ⁻¹	CLASS
Benzene	NA	NA	NA	2.9E-02 a	A
N-Butylbenzene	NA	NA	NA	NA	NA
Sec-Butylbenzene	NA	NA	NA	NA	NA
Tert-Butylbenzene	NA	NA	NA	NA	NA
Ethylbenzene	1E+00 b	1E-01 a	Hepatotoxicity, nephrotoxicity	NA	D
Isopropylbenzene	NA	NA	NA	NA	NA
P-Isopropyltoluene	NA	NA	NA	NA	NA
Naphthalene	4.0E-03 b	4.0E-03 b	Ocular and internal lesions	NA	D
N-Propylbenzene	NA	NA	NA	NA	NA
Toluene	4E-01 b	3E-01 a	CNS Effects	NA	D
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA
1,3,5-Trimethylbenzene	NA	NA	NA	NA	NA
Xylenes	4E+00 b	2E+00 a	Hyperactivity, Decr. Body Weight	NA	D
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA

NOTES:

1. Dose-Response information obtained from the following:

- a. U.S. EPA, Integrated Risk Information System (IRIS). Chemical Files. Dialcom/BT Tymnet Computer Communication Service. April, 1990.
- b. U.S. EPA. Health Effects Assessment Summary Tables (HEAST). Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response. Fourth Quarter FY 1989. October, 1989.

2. Weight of Evidence Classification:

Group A: Human Carcinogen	Group D: Not Classified
Group B: Probable Human Carcinogen	Group E: No Evidence of Human Carcinogenicity
Group C: Possible Human Carcinogen	

3. Dose-response values are not available for direct contact exposure, therefore values for exposure through ingestion were used.
4. Xylenes include Ortho, Meta, and Para isomers of Xylene.
5. NA = Not Applicable or Not Available

TABLE 5 (continued)
SUMMARY OF DOSE-RESPONSE INFORMATION
FOR INHALATION EXPOSURE

COMPOUND	NONCARCINOGENIC EFFECTS			CARCINOGENIC EFFECTS	
	Subchronic RfD (mg/kg/day)	Chronic RfD (mg/kg/day)	HEALTH EFFECT(S) OF CONCERN	CPF (mg/kg/day)-1	CLASS
Benzene	3E-03 c	3E-03 c	NA	2.9E-02 a	A
N-Butylbenzene	NA	NA	NA	NA	NA
Sec-Butylbenzene	NA	NA	NA	NA	NA
Tert-Butylbenzene	NA	NA	NA	NA	NA
Ethylbenzene	2E-01 c	2E-01 c	NA	NA	D
Isopropylbenzene	NA	NA	NA	NA	NA
P-Isopropyltoluene	NA	NA	NA	NA	NA
Napthalene	ND b	ND b	NA	NA	D
N-Propylbenzene	NA	NA	NA	NA	NA
Toluene	6E-01 b	6E-01 b	CNS Effects, eyes & nose irritation	NA	D
1,2,4-Trimethylbenzene	ND b,d	ND b,d	NA	NA	NA
1,3,5-Trimethylbenzene	ND b,d	ND b,d	NA	NA	NA
Xylenes	9E-02 b	9E-02 b	CNS Effects, nose & throat irritation	NA	D
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA

NOTES:

1. Dose-Response information obtained from the following:

- a. U.S. EPA, Integrated Risk Information System (IRIS). Chemical Files. Dialcom/BT Tymnet Computer Communication Service. April, 1990.
- b. U.S. EPA. Health Effects Assessment Summary Tables (HEAST). Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response. Fourth Quarter FY 1989. October, 1989.

Inhalation RfDs for toluene and xylene were calculated from the acceptable concentration (in mg/m³) using standard exposure assumptions:

$$\text{RfD (mg/kg/day)} = \text{conc (mg/m}^3\text{)} \times 20 \text{ m}^3 \text{ air/day} \times 1/70 \text{ kg bodyweight}$$

- c. Massachusetts Department of Environmental Protection. Guidance for Disposal Site Risk Characterization and Related Phase II Activities - In Support of the Massachusetts Contingency Plan. Office of Research and Standards. May 17, 1989.

Inhalation acceptable doses (AD) were calculated from ATC's using standard exposure assumptions:

$$\text{AD in (mg/kg/day)} = \text{ATC (ug/m}^3\text{)} \times 20 \text{ m}^3 \text{ air/day} \times 1/70 \text{ kg bodyweight} \times 1 \text{ mg/1000 ug}$$

These values were used for chronic and subchronic effects.

- d. Current data inadequate for quantitative risk assessment.

2. Weight of Evidence Classification:

- | | |
|------------------------------------|---|
| Group A: Human Carcinogen | Group D: Not Classified |
| Group B: Probable Human Carcinogen | Group E: No Evidence of Human Carcinogenicity |
| Group C: Possible Human Carcinogen | |

TABLE 6
DRINKING WATER STANDARDS & GUIDELINES
FOR COMPOUNDS DETECTED IN
GROUNDWATER

COMPOUND	MASSACHUSETTS DRINKING WATER STANDARDS		FEDERAL STANDARDS	
	MMCLs (mg/l)	GUIDELINES (mg/l)	MCLs (mg/l)	MCLGs (mg/l)
VOLATILE ORGANICS				
Benzene	0.005	NA	0.005	0
Ethylbenzene	NA	0.7	0.7 *	0.7 *
Toluene	NA	2	2 *	2 *
Xylenes (total)	NA	1	10 *	10 *
N-Butylbenzene	NA	NA	NA	NA
sec-Butylbenzene	NA	NA	NA	NA
tert-Butylbenzene	NA	NA	NA	NA
Isopropylbenzene	NA	NA	NA	NA
P-Isopropylbenzene	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA
N-Propylbenzene	NA	NA	NA	NA
1,2,4-Trimethylbenzene	NA	NA	NA	NA
1,3,5-Trimethylbenzene	NA	NA	NA	NA
Total Petroleum Hydrocarbons	NA	NA	NA	NA

NOTES:

1. Massachusetts Standards and Guidelines obtained from: Department of Environmental Protection, 1989. Guidance for Disposal Site Risk Characterization and Related Phase II Activities - In Support of the Massachusetts Contingency Plan. Office of Research and Standards. Update: October 1989.
2. Federal Standards taken from: National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142 and 143. Values listed with an asterisk (*) are proposed standards, as listed in 50FR46936 (November 13, 1985) and 54FR22062 (May 22, 1989).
3. MCL - Maximum Contaminant Level
MCLG - Maximum Contaminant Level Goal
4. NA = No Federal or Massachusetts standards or guidelines are available.

TABLE 7
EXPOSURE ASSESSMENT SUMMARY

<u>Receptor</u>	<u>Time Frame</u>	<u>Activity</u>	<u>Exposure Point</u>	<u>Medium</u>	<u>Route</u>
Adult Construction Worker	future	Excavation of site	Facility Grounds	Soil* Soil gas* (volatilization)	Dermal Contact Ingestion Inhalation
Adult and Child Residents	future	Consumption of drinking water, household use of water	Residences Supplied by Wells G&H	Groundwater	Ingestion Inhalation Dermal Contact
Adults and Child Residents	future	Incidental contact	Aberjona River	Surface Water	Dermal Contact Incidental Ingestion

Notes:

*Indicate media for which measured concentrations are available. For others, concentrations will be estimated using modeling techniques.

TABLE 8

U.S. EPA AMBIENT WATER QUALITY CRITERIA
FOR SURFACE WATERS

COMPOUND	FRESHWATER	
	CHRONIC LOEL (ug/l)	ACUTE LOEL (ug/l)
Benzene	NA	5300
Ethylbenzene	NA	32,000
Toluene	NA	17,500
P&M Xylenes	NA	NA
O-Xylene	NA	NA
N-Butylbenzene	NA	NA
Isopropylbenzene	NA	NA
P-Isopropyltoluene	NA	NA
Naphthalene	620	2300
N-Propylbenzene	NA	NA
Sec-Butylbenzene	NA	NA
Tert-Butylbenzene	NA	NA
1,2,4-Trimethylbenzene	NA	NA
1,3,5-Trimethylbenzene	NA	NA

NOTES:

1. U.S. EPA Ambient Water Quality Criteria obtained from: Quality Criteria for Water. 1986. United States Environmental Protection Agency, Office of Water, Regulations and Standards, Washington D.C. EPA 440/5-86-001.
2. LOEL - Lowest Observable Effect Level
3. NA = No EPA Criteria are available



The Commonwealth of Massachusetts

Department of Environmental Protection

Metropolitan Boston - Northeast Region

5 Commonwealth Avenue

Woburn, Massachusetts 01801

Daniel S. Greenbaum
Commissioner

(617) 935-2160

August 6, 1990

Ms. Sara Hanna
Goldberg Zoino & Associates, Inc.
The Geo Building
320 Needham Street
Newton Upper Falls, MA 02164

RE: WOBURN - 60 Olympia Avenue
DEP Case No. 3-0594

Dear Ms. Hanna:

The Department of Environmental Protection (DEP) has reviewed the Phase II Risk Characterization Scope of Work for the 60 Olympia Avenue site in Woburn, Massachusetts prepared by Goldberg Zoino & Associates, Inc. (GZA) and dated May 1990.

While the Scope of Work addressed all the major components required in the risk characterization, clarification of the following items must be provided before approval of the Scope of Work can be granted.

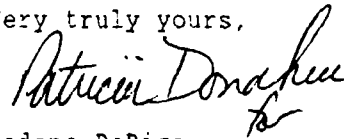
1. The chlorinated VOCs detected in soil and groundwater on-site must be carried through the risk characterization. The Endangerment Assessment for the Wells G & H Site prepared by Ebasco Services, Inc. for the EPA, addressed contaminants west of the Aberjona River. Chlorinated VOCs were not detected or only detected at trace concentrations in soil in this area. Soil and groundwater contaminants in the area of the underground storage tanks include the chlorinated VOCs and they must be included in the risk characterization in order to achieve an accurate assessment of total site risk as required in the Massachusetts Contingency Plan, 310 CMR 40.000.
2. Section 2.32 Identification of Exposure Point Concentrations states, "whenever possible, actual monitoring will be used to identify exposure point concentrations. Monitoring data from GZA's October 1988 Hydrogeological Assessment Report, and October 1989 Soil Gas Survey will be used to help identify soil exposure concentrations." As stated in the addendum to the Phase II Scope of Work, a soil sample from each boring was analyzed for VOCs using EPA Method 8240. This data should be used to establish exposure point concentrations in soil.

Page 2

3. Exposure point concentrations for inhalation during construction activities should be established using soil gas data to represent worst case conditions. Should the risk limits be exceeded by this exposure route, further modeling of the soil gas data may be performed using pre-approved dispersion models.

The aforementioned issues should be addressed in an addendum to the Scope of Work and submitted to the Department for review. If you have any questions regarding this matter, please contact Rodene DeRice at (617)935-2160.

Very truly yours,



Rodene DeRice
Environmental Analyst



Richard J. Chalpin
Regional Engineer

RJC/RD/ram

cc: Mr. Charles Whitten, Juniper Development Group, 39 Holton St., Winchester,
MA 01890
DEP/BWSC, Boston
BOH, 33 Plympton St., Woburn, MA 01801

APPENDIX C

QUALITY ASSURANCE/QUALITY CONTROL MEASURES

APPENDIX C
QUALITY ASSURANCE/QUALITY CONTROL PLAN

PHASE II
COMPREHENSIVE SITE ASSESSMENT
60 OLYMPIA AVENUE
WOBURN, MASSACHUSETTS

PREPARED FOR:
Juniper Development Group
Winchester, Massachusetts

PREPARED BY:
GZA GeoEnvironmental, Inc.
Newton Upper Falls, Massachusetts

July 1991
File No. 4596.2

Approvals:

Project Manager

Senior Principal

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1.00 GENERAL INFORMATION

1.10 PROJECT DESCRIPTION

This project consists of a Phase II - Comprehensive Site Assessment of the 60 Olympia Avenue site in Woburn, Massachusetts. The study is designed to meet the specific requirements of the Massachusetts Contingency Plan as outlined in 310 CMR 40.545. Further description of the site and project background information are provided in Section 1.00 of the Phase II - Scope of Work.

1.20 PROJECT ORGANIZATION AND RESPONSIBILITIES

Mr. John J. Balco will be the Principal-In-Charge for the project, maintaining ultimate responsibility for work staffing and completion. Ms. Sara Hanna will be Project Manager for the work, managing the field investigation, data evaluation and report development phases of the work. Quality Assurance/Quality Control (QA/QC) for the project will be independently monitored by the Consultant/Reviewer, Mr. William R. Norman. Field and office staff of the project will report to the Project Manager.

1.30 QA OBJECTIVES

The overall objective of the quality assurance program is to insure collection and analysis of samples in a way such that evaluations performed for the Phase II - Assessment are scientifically reliable and supportable. The precision and accuracy of field measurements will be maintained by adherence to appropriate GZA Standard Operating Procedures (SOPs). For laboratory measurements of chemical parameters, precision and accuracy goals are specified in the analytical protocol and laboratory QA/QC program. The general focus of the quality control program is to provide an internal review of field procedures; sample collection, transport and preservation procedures; and analytical protocols to ensure that the data generated during the course of the Phase II - Assessment is scientifically reliable.

2.00 FIELD DATA QA/QC

2.10 FIELD SAMPLING AND TESTING PROCEDURES

Quality control for field measurements will be assured by conformance with SOPs for these activities. Field work will be documented by maintaining the following:

- Boring and groundwater sampling logs
- Field activity summary sheets
- Sample identification documents
- Sample labels
- Chain-of-custody records

Any deviation from the SOPs will be documented in the field summary sheets, and discussed in the Phase II report.

2.20 SAMPLE LABELLING, CONTROL AND CUSTODY

The accountability of a sample begins when the sample is removed from its natural environment. Sample labels, chain-of-custody forms, and field data records (boring logs) will be completed at the time of sampling. Chain-of-custody forms are to be filled out completely in accordance with relevant SOPs. Entries will be made in waterproof ink during sampling. The following chain-of-custody procedure will be implemented by the field representative to promote sample integrity.

The samples are under custody of the field sampler if:

- they are in his (or her) possession;
- they are in view after being in possession;
- they are locked up or sealed securely to prevent tampering; or
- they are in a designated secure area.

The original of the chain-of-custody form will accompany the samples at all times after collection. A copy of the chain-of-custody form is kept by the field sampler.

When samples are transferred in possession, the individuals relinquishing and receiving will sign, date, and note the time on the chain-of-custody form.

When samples are shipped, the field sampler will note the method of shipment, courier name, and way bill number in the "remarks" box on the form. The field sampler will keep a copy of the way bill and attach it to his (or her) copy of the chain-of-custody form.

The chain-of-custody form will contain information to distinguish each sample from other samples. This information will include:

- the project for which sampling is being conducted;
- the matrix being sampled (air, groundwater, soil, etc.);
- the sampling date and time;
- the specific sampling location;
- the method of sampling to include preservation techniques (refer to Section 2.32.1 of Scope of Work);
- significant observations made during the sampling process;
- signature of the person performing the sampling.

Each sample will be assigned a unique identification number, marked on the sample container in waterproof ink, and recorded on the chain-of-custody form. The chain-of-custody form will be forwarded to the laboratory with the samples. As a precaution against this record being lost or altered, the sampling personnel will retain a copy of the chain-of-custody form documenting the information up until the first change of sample custody. This record will be filed by the Project Manager. Field measurements (e.g., pH, specific conductance, temperature, depth, flow, etc.) will be recorded on the field data record sheets or field log books.

2.30 SAMPLE HANDLING AND SHIPMENT

Collection, containment, preservation, handling and shipment of samples will be completed in accordance with the appropriate EPA, ASTM, or other methods for the analytical parameters of interest. These are listed in the sampling and analysis plan. Appropriate containers and preservation techniques will be employed to ensure sample integrity and chain-of-custody protocols will be observed during shipment.

2.40 FIELD EQUIPMENT CALIBRATION

Field instruments used during the Phase II - Assessment will be periodically calibrated to ensure accuracy. Calibration and preventive maintenance for field instruments are described below; calibration information will be maintained in field log books or sampling logs.

2.41 pH Meter Calibration

The pH meter must be calibrated a minimum of twice each day using two different pH buffer solutions expected to bracket the pH range of field samples. Rinse the probe thoroughly between measurements with distilled water and again after calibration is completed. Record in the field log book what buffer solutions were used. When the meter is moved, check pH reading by measuring the pH value of the buffer solution closest to the expected range of the sample. If the reading deviates from the known value by more than 0.1 standard units, recalibrate the instrument as described above. If unacceptable deviations still occur, consult the operating manual for remedial course of action.

2.42 Conductivity Meter Calibration

The specific conductance/temperature meter is less likely to exhibit random fluctuations and will only require daily checks against a known KCL solution, which should be chosen to be within the expected conductivity range. Note that specific conductance is temperature-dependent and therefore the meter readings must be adjusted to reflect the temperature of the standard solution. Thoroughly rinse the probe with distilled water after immersing in KCL standard solution. In addition to daily checks of the conductivity readings, the thermistor readings must also be checked daily. This is accomplished by taking a temperature reading of the KCL standard solution with both the conductivity probe and mercury thermometer.

2.43 PID Calibration

The photoionization organic vapor detector (H-Nu) will be calibrated daily using an analyzed gas mixture provided in a pressurized container, according to the manufacturer's instructions. Battery check with electronic zeroing of the instrument will be performed at two-hour intervals during periods of continuous use.

2.44 Thermometer Inspection

Before use, the thermometer will be visually inspected to assure there is no break in the liquid column. If there is a break, the spare thermometer will be visually inspected. If both thermometers have a break in the liquid, neither can be used and a replacement must be obtained.

2.50 FIELD QA/QC SAMPLES

QA/QC samples to be submitted to the laboratory include (1) trip blanks; (2) field blanks; and (3) duplicates. These samples provide a quantitative basis for validating the data reported.

2.51 Trip Blanks

Trip blanks are used to assess the concentrations of volatile organics reported in water samples. The trip blank, which is prepared by the laboratory, consists of a VOC sample container filled with reagent water which is shipped to the site with the other VOC sample containers. Two trip blanks are included with each shipment of water samples scheduled for volatile organic analysis. The containers are carried to the field and are stored with the samples during sampling activities. One of the two trip blanks may be analyzed with the environmental VOC samples; the second blank can also be analyzed if VOCs are detected in the first.

2.52 Field Blanks

Field blanks will be prepared during each sampling event using organic-free water (in groundwater sampling rounds) or clean silica sand (soil sampling rounds). The field blank will be handled as a sample using sampling equipment and containers.

This blank will be analyzed for VOCs and for other be, as appropriate. At least one field blank will be collected per sampling event.

2.53 Duplicates

Duplicates of environmental samples amounting to an average of 10 percent of each type of sample (e.g., soil, groundwater) will be submitted for analysis of all parameters specified for those samples. The identity of the duplicate samples will not be revealed to the laboratory.

3.00 LABORATORY QA/QC

3.10 ANALYTICAL PROCEDURES AND QA/QC

GZA's Environmental Chemistry Laboratory's (ECL) analytical methodologies are presented in the sampling and analysis plan. Contract laboratory analysis procedures will conform to appropriate EPA protocols for the parameters of interest (refer to the sampling and analysis plan for specific method references). QA/QC for GZA and outside contract laboratory analyses will be maintained by adherence to relevant protocols, laboratory QA/QC procedures and DEP guidance ("Minimum Standards for Submission of Analytical Data for Remedial Response Actions under MGL C21E," dated January 19, 1990).

4.00 QA AUDITING

4.10 PERFORMANCE AUDITS

GZA's ECL actively participates in EPA interlaboratory performance evaluation programs. Contract laboratories used in this study will also be participants in these programs. Internal audits are also a component of each laboratory's QA/QC program.

For field measurements and data evaluation tasks, the GZA Project Manager will monitor QA procedures to ensure that data of acceptable quality are provided. Calculations will be independently checked by GZA technical staff. Data summaries, interpretive plans and written reports will be developed by the project manager and technical staff and reviewed by the Associate Principal-In-Charge. This information will also be independently reviewed by a senior technical staff member (Project Consultant/Reviewer).

4.20 PROCEDURES TO ASSESS PRECISION, ACCURACY AND COMPLETENESS

For analytical data, routine procedures to assess precision, accuracy, and completeness are outlined in the relevant analytical protocols and the laboratory's internal QA plans. Precision, the degree to which a measurement is reproducible, is assessed by comparison of replicate analyses. Accuracy is an assessment of the degree of agreement of a measurement with an accepted reference value. This is usually reported as percent recovery, referenced to a surrogate standard or known quantity of an added analyte. Completeness is a measure of the percentage of valid data obtained compared with the amount that was expected to be obtained.

4.30 CORRECTIVE ACTION

When data is found to be incomplete or unacceptable or non-conformance with stated QA objectives is noted, corrective action steps shall be initiated. The Project Manager or Consultant/Reviewer shall notify the Associate Principal-In-Charge and take corrective actions. These may include:

- For data omission, resampling or reanalysis of the sample in question;
- For conflicting data, review of supporting documentation, followed by resampling and/or analysis if necessary;
- For data which falls outside of acceptable ranges for precision or accuracy, the cause of the poor performance shall be evaluated. An explanation of

performance deficiencies shall be provided and resampling/reanalysis conducted if deemed necessary by the Associate Principal-In-Charge.

4.40 REPORTING

QA/QC procedures employed during the project will be documented in the Phase II - Report. Laboratory QA/QC protocols and data documenting analytical accuracy and precision will be included in the laboratory data reports. Results of performance, audits, identification of significant QA/QC problems, and any corrective action steps taken will be included in the discussion of QA/QC in the Phase II - Report.

APPENDIX D
HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

GOLDBERG-ZOINO & ASSOCIATES, INC.

This plan is applicable for sites where the work involves the evaluation of potential chemical contamination (ENVIRONMENTAL SITE ASSESSMENTS), and where historical review, previous sampling results, site location, or other considerations indicate that the major chemical contaminants suspected are:

PETROLEUM PRODUCTS--GASOLINE and/or OILS & GREASE

JOB NAME Phase II Study, Olympia Nominee Trust JOB NO. A-4596.1
 SITE LOCATION 60 Olympia Avenue, Woburn, MA.
 SITE DESCRIPTION/NATURE OF WORK Site is a trucking terminal.
Field work will include soil gas survey, test borings,
well installation, and groundwater and surface water
sampling for a Phase II study under the Mass. Contingency Plan.
 DIG SAFE NOTIFIED? yes BY WHOM Sara Hanna DATE 6/28/89
 RESPONSE Site cleared after 7/3/89 @ 1:45 ^{notifying Boston Edison, Boston Gas,}
H.E. Telephone, and AT&T
 * DIG SAFE FILE NO. 89263617 Re-cleared 8/2/89 Mon Aug 7 after 1:00
8931-3559
 PRIMARY LEVEL OF PROTECTION: Level D or Modified Level D, as appropriate
 CONTINGENCY LEVEL OF PROTECTION: Level C
 MAP OF ROUTE TO NEAREST HOSPITAL ATTACHED: YES ☒ NO ☐
 EMERGENCY PHONE NUMBERS 911
 AMBULANCE: 933-3131 FIRE: 933-3131 POLICE: 933-1212
 HOSPITAL: Name Choate Hospital
 Address 21 Warren Avenue, Woburn, MA
 Hospital Phone Number 933-6700
 OTHER: _____ PHONE NO. _____
 _____ PHONE NO. _____
 LOCATION OF NEAREST PHONE: at site

Re-cleared 11/10/89 - clean after 11/15/89 @ 4:00. Digsafe file # 89455191

SITE HAZARDS

PETROLEUM PRODUCTS KNOWN OR SUSPECTED TO BE PRESENT:

gasoline, fuel oil. There is also a waste oil tank on site.
Low-level chlorinated solvents (<1 ppm) have been detected in
one boring adjacent to waste oil tank.

SOURCE AND EXPECTED LOCATION OF CHEMICAL CONTAMINATION: _____

There are currently underground tanks on site; additional tanks
have been removed. Some of the tanks failed permeability tests, \Rightarrow tank
leakage is probable source. Add'l sources may include leaks in piping
and/or surface spillage.

OTHER SITE-SPECIFIC CONSIDERATIONS: _____

No other site specific considerations regarding oil
or hazardous material. Site is a trucking terminal \Rightarrow
use caution around trucks.

ROUTES OF EXPOSURE, SYMPTOMS, HEALTH EFFECTS:

Fuel oils are generally low in toxicity, they have low volatility, and are not readily absorbed through the skin, however they may cause skin irritation, or "dermatitis", upon contact.

Waste oils may contain certain cancer-causing components such as heavy metals and oil derivatives which can be absorbed through the skin.

Gasoline is considered more toxic than oils, it has relatively high volatility, and certain components are readily absorbed through the skin. Gasoline contains certain components, such as benzene, which are classified as potential carcinogens. The Threshold Limit Value for gasoline is 300 ppm.

The symptoms of inhalation over-exposure to petroleum products include dizziness, loss of coordination, general malaise, and nausea.

PHYSICAL HAZARDS:

If drilling, the general types of hazards associated with a drill rig are present, namely, slips and falls, falling objects, hand, foot and back injuries, etc. If digging test pits, the additional hazards of a swinging backhoe bucket, collapse of excavation, etc., exists.

NOISE HAZARDS:

The noise associated with operation of a drill rig or other heavy equipment can cause permanent, irreversible hearing loss. "Impact noise", such as that caused by driving a well point or split spoon with a drill rig hammer, is especially dangerous. Proper hearing protection (ear muffs or plugs) should be used when working near a source of loud noise.

SITE PERSONNEL REQUIREMENTS

MEDICAL MONITORING: Site personnel must participate in GZA's medical monitoring program and must have had their most recent exam within the previous 12 months. The exam must have indicated no medical restrictions that would inhibit personnel from performing the required work tasks.

HEALTH & SAFETY TRAINING: Site personnel must have had at least 40 hours of relevant health and safety training and/or equivalent experience which included coverage of hazard recognition, use of site monitoring instruments, use of personal protective equipment, etc.

SITE HEALTH & SAFETY PROCEDURES

PROCEDURES FOR NON-INTRUSIVE WORK (Site "Walk-Over", Geophysical Work, etc.):

No special procedures or equipment required
for non-intrusive work-

PROCEDURES FOR INTRUSIVE SITE WORK (Drilling, Test Pits, etc.):

A. PERSONAL PROTECTIVE EQUIPMENT:

1. "Ready bags" should be present at the site. (See the Ready Bag Checklist attached to this plan.)

B. MONITORING EQUIPMENT:

Photo-Ionization Detector (PID): H-Mu, 10.2eV, or equivalent PID

O₂ / LEL meter

C. OTHER EQUIPMENT: An alternative to the PID, for health and safety purposes, is the Sensidyne Gastech Pump with indicator tube for petroleum hydrocarbons.

D. SITE CONTROL:

Do not allow visitors, onlookers, or other unauthorized personnel within 25 feet of drill rig, test pit, etc. If work site is located in an unsecured area with possible pedestrian access, mark off work area with traffic cones, caution tape, warning placards, etc., as appropriate.

E. WORK PROCEDURES (also see Section G, "Site-Specific H & S Procedures"):

- * Begin working in Level D (Standard Work Clothes, Boots, Hardhats), unless Section G, calls for Modified D.
- * No Smoking near borehole or test pit.
- * Wear hearing protection if working near an operating drill rig or other source of loud noise.
- * Wear Bayprene or Nitrile gloves when handling soil samples.
- * Monitor soils with the PID (and O2/LEL meter if specified above).
- * If soils contaminated with oil and/or gasoline are encountered, proceed with Modified Level D protection, as appropriate (overboots, Tyvek suit, chemical-protective gloves, etc.), and monitor the breathing zone as well as soils with the PID (and O2/LEL meter if specified above).
- * Be prepared to elevate to Level C protection. Observe action levels as provided below.

IMPORTANT: IF SITE PERSONNEL SHOW SIGNS AND SYMPTOMS OF CHEMICAL EXPOSURE, DISCONTINUE WORK AND FOLLOW APPROPRIATE EMERGENCY PROCEDURES!

IF SITE OBSERVATIONS, ODORS, OR ANY OTHER INFORMATION INDICATES THAT CONTAMINANTS OTHER THAN PETROLEUM PRODUCTS ARE PRESENT, STOP WORK, AND CONTACT THE PROJECT MANAGER OR HEALTH & SAFETY REP. FOR FURTHER INSTRUCTIONS. IF FURTHER INSTRUCTIONS ARE NOT AVAILABLE, DISCONTINUE WORK AT THAT LOCATION.

F. ACTION LEVELS

1. Photo-Ionization Detector--breathing zone readings:

- 0 to 25ppm.....remain in Modified Level D (or Level D if appropriate)
- > 25ppm.....go to level C

At levels consistently above 100 ppm in the breathing zone, discontinue working at that location and notify the Project Manager and Health & Safety Rep.

✓ 2. O2/LEL Meter (if specified in Section B above):

- If oxygen levels in the breathing zone go below 19.5%, leave the work area temporarily until vapors dissipate. If oxygen deficiency continues to be a problem, discontinue work at that location and consult with health & safety rep. regarding necessary precautions.
- 0 to 25% LEL near soils...work with caution
- > 25% LEL near soils.....discontinue working at that location and make arrangements for vapor control (i.e. foam, etc.)

G. SITE-SPECIFIC H & S PROCEDURES: The LEL for gasoline is 1.3%
or 13,000 ppm. ~~Take proper precautions to prevent fire if vapor levels near the drilling spoils exceeds the detection range of the HNU (2000 ppm) or the indicator tubes (1000 ppm).~~
Take proper precautions to prevent fire if vapor levels near the drilling spoils exceeds the detection range of the HNU (2000 ppm) or the indicator tubes (1000 ppm).

H. PERSONNEL & EQUIPMENT DECONTAMINATION:

- Remove gross contamination from tools, respirator, monitoring equipment, boots, etc. prior to leaving the work-site, using water, paper towels, handi-wipes, etc.
- Either completely decontaminate soiled equipment at the work-site using detergent & water (if possible), or wrap equipment in plastic bag for transport until complete decontamination is possible.
- Dispose of contaminated gloves, Tyvek suits, used cartridges, paper towels, etc. by placing in a plastic bag and discarding in regular trash.
- Wash hands & face thoroughly with soap and water before lunch or coffee breaks, and as soon as practicable after finishing work for the day.

EMERGENCY PROCEDURES

PERSONAL INJURY--Administer appropriate first aid. If injury is serious, transport the victim to the nearest hospital. If possible, notify hospital in advance of incoming patient and nature of injury. If there is a question about whether it is safe to move the victim, DO NOT move the victim--instead, make him/her as comfortable as possible, and summon emergency assistance.

CHEMICAL EXPOSURE--If site personnel show signs of inhalation exposure, retreat to fresh air for recovery. If symptoms are serious, such as nausea or fainting, bring the victim to the nearest hospital for observation, and discontinue work at that location and consult with M & S representative.

In case of skin or eye irritation due to chemical contact, wash affected skin with soap and water, or flush eyes with generous amounts of water. If irritation is serious, seek medical attention.

FIRE--If fire can be easily contained and extinguished, do so with fire extinguisher. If explosion risk is present, do not attempt to extinguish--evacuate all personnel to a safe area and call the fire department.

IMPORTANT NOTE: IF SITE OBSERVATIONS, SAMPLING RESULTS, OR ANY OTHER INFORMATION INDICATES THE PRESENCE OF CHEMICAL CONTAMINANTS OTHER THAN PETROLEUM PRODUCTS, THIS HEALTH & SAFETY PLAN BECOMES VOID, AND A NEW PLAN MUST BE PREPARED AND APPROVED!

PROJECT MANAGER John Balco PIC/AIC John Balco

HEALTH & SAFETY PLAN PREPARED BY Sara Hanna DATE 4/11/89

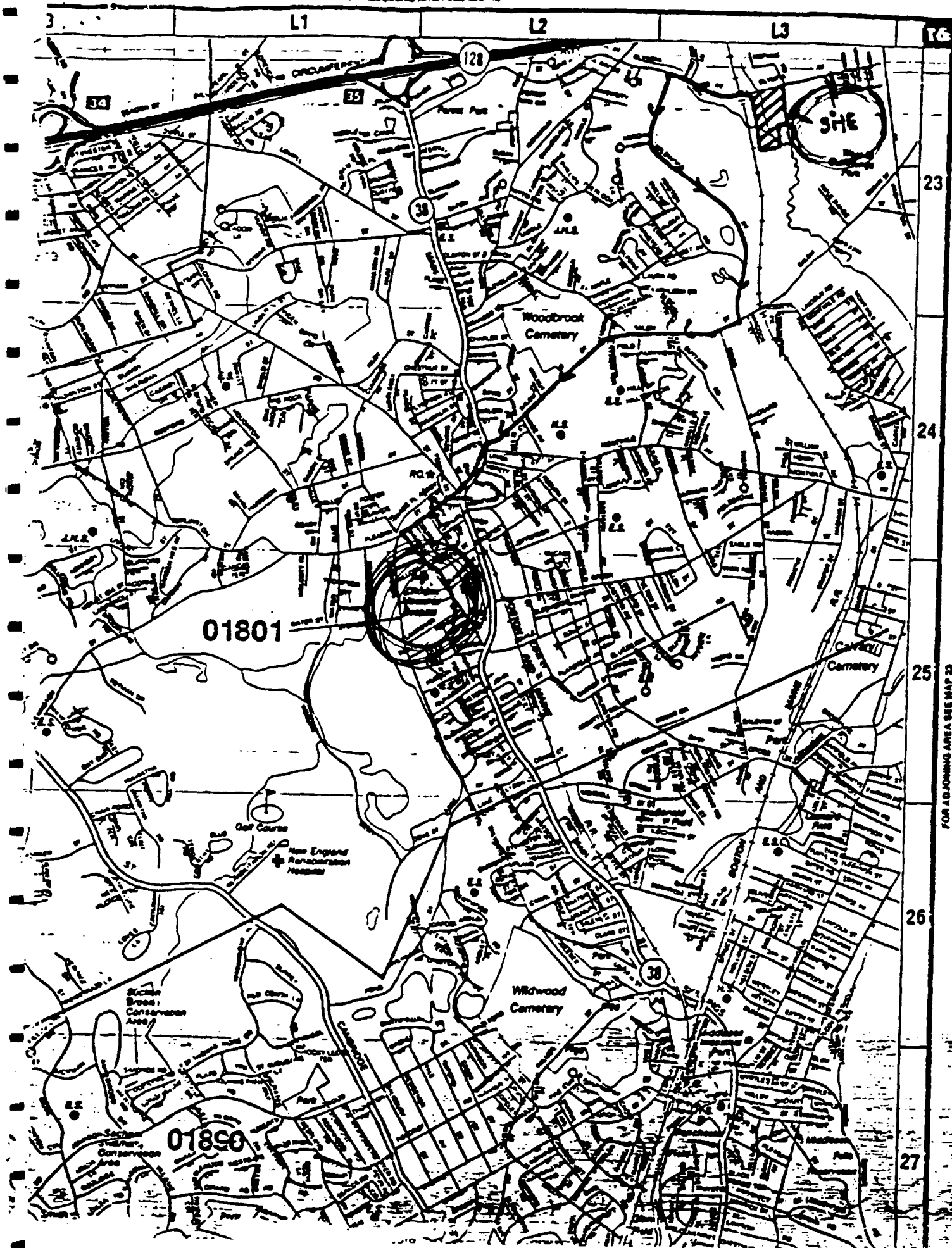
HEALTH & SAFETY PLAN APPROVED BY Mark P. Mulch DATE 11/21/89

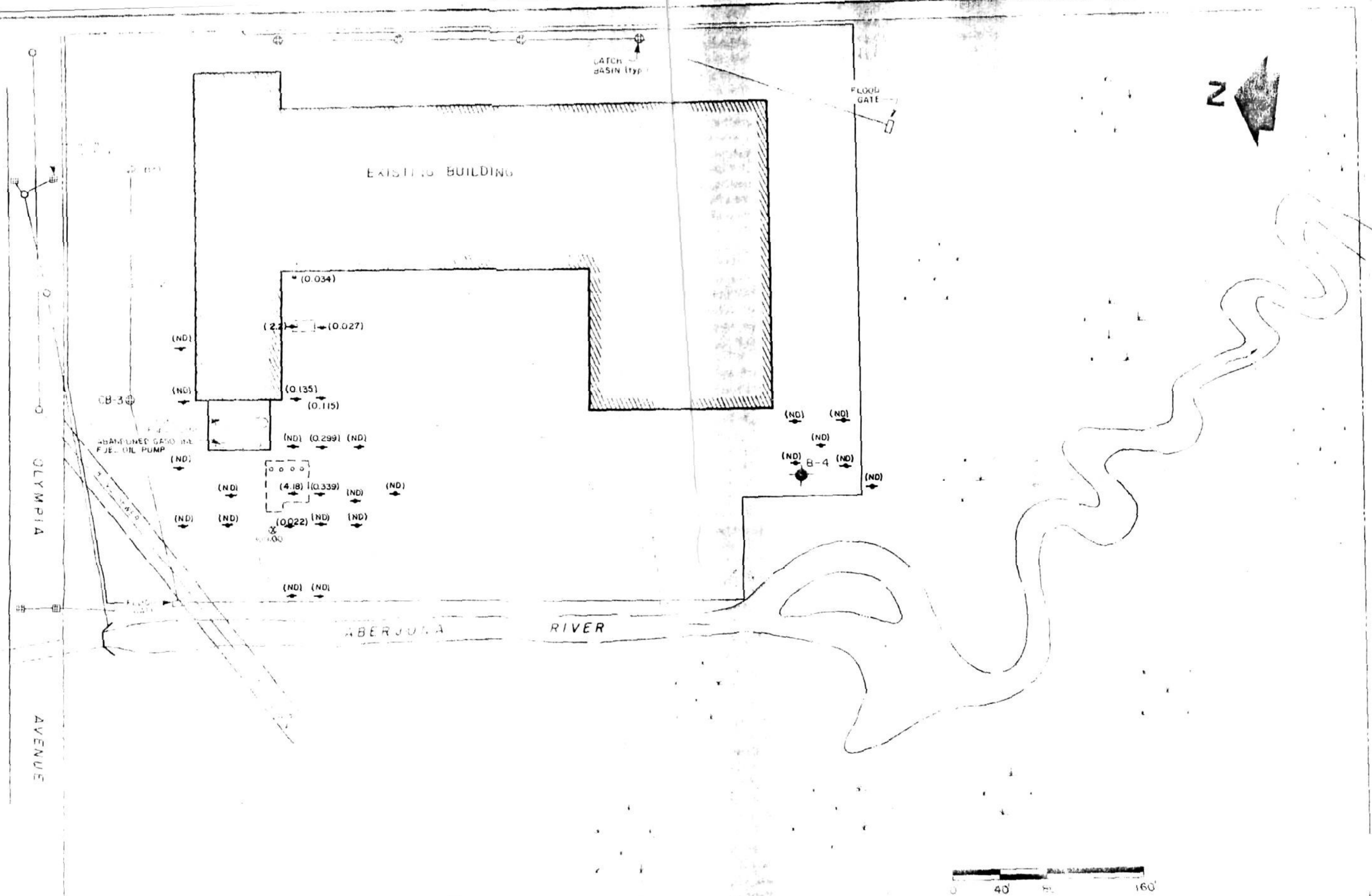
Goldberg-Zoino & Associates, Inc.

READY-BAG CHECKLIST

- _____1. MSA Ultratwin full-face air-purifying respirator, in a protective plastic bag.
- _____2. Nose-cup insert for MSA Ultratwin respirator.
- _____3. MSA ear-muff set which fits into hardhat or earplugs.
- _____4. Optional: Eyeglass kit for MSA Ultratwin respirator.
- _____5. MSA cartridges for respirator, type GMC-M, color-coded yellow and magenta.
- _____6. Protective lense cover for MSA Ultratwin respirator.
- _____7. Hardhat
- _____8. Latex gloves.
- _____9. Nitrile gloves.
- _____10. Poly-laminated Tyvek suit.
- _____11. Safety glasses.
- _____12. Plastic disposal bag.
- _____13. Outer Rubber Boots.
- _____14. NIOSH Pocket Guide To Chemical Hazards.
- _____15. Eyewash Bottle.

Note: The equipment listed above comprises the standard GZA "Ready Bag", and will provide appropriate protection from chemical exposure and noise in most situations encountered. However, for a particular job, certain items which are not included in the standard ready bag may be required, for example, a different type of coverall or respirator cartridge. Therefore, the Site-Specific Health and Safety Plan should always be consulted to make sure the proper equipment is brought to the site.





- NOTES:
- 1) BASE MAP DEVELOPED FROM A MAP PROVIDED BY THE NEW ENGLAND CORP. ENTITLED "DRAINAGE PLAN - WOBURN, MASS." DATED 11/25/83, ORIGINAL SCALE 1" = 100'.
 - 2) THE LOCATIONS OF THE DATA POINTS WERE APPROXIMATELY DETERMINED BY TAPE MEASUREMENTS AND "LINE OF SIGHT" FROM EXISTING TOPOGRAPHIC FEATURES. THESE DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE INDICATED BY THE METHOD USED.
 - 3) REFER TO FIGURE NO. 1 FOR ADDITIONAL INFORMATION.

- LEGEND:
- ND TOTAL CONCENTRATION OF THE COMPOUNDS (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES) (ug/m, vol/vol)
 - ND INDICATES NO BTEX COMPOUND DETECTED
 - SOIL GAS MONITORING LOCATION



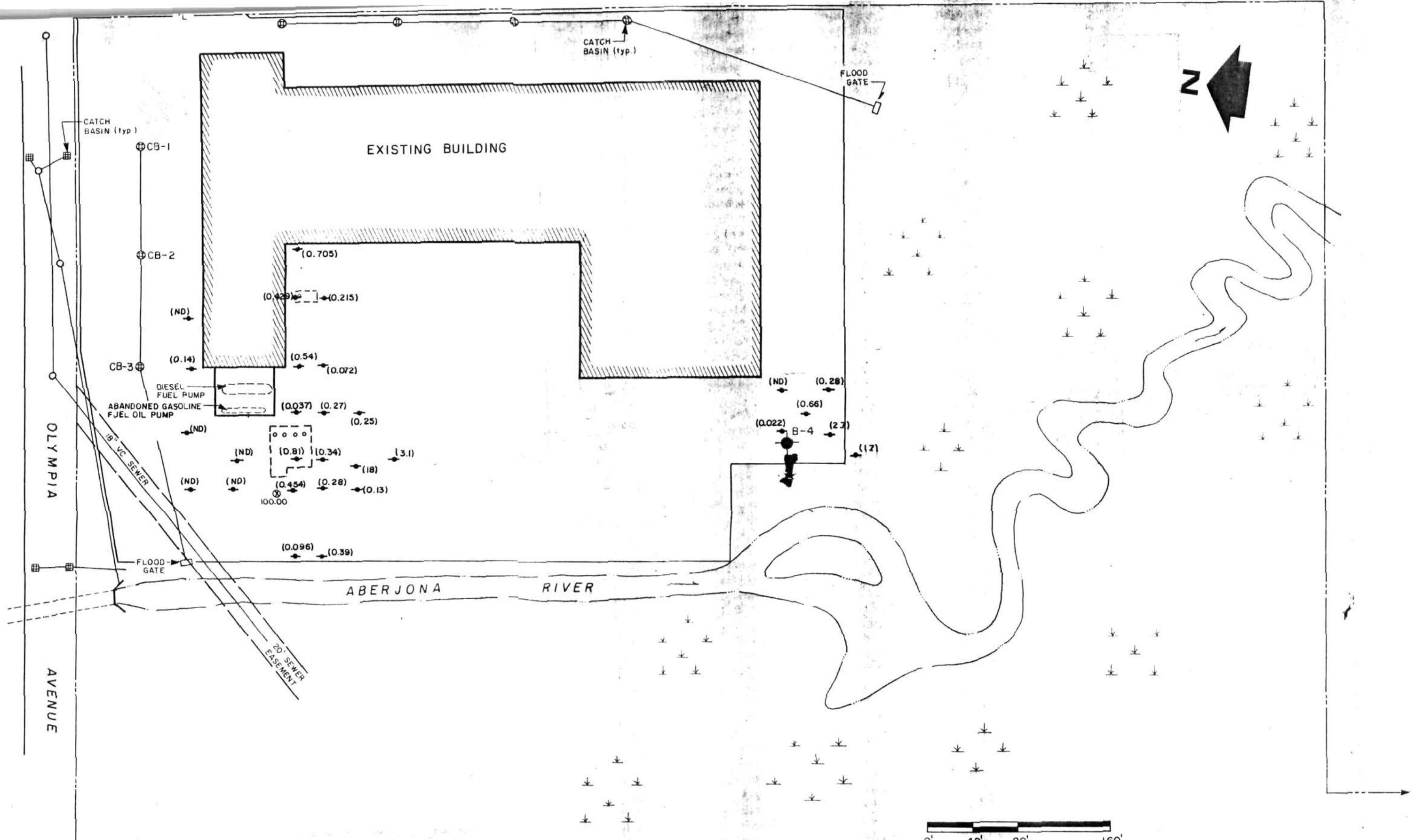
PROPERTY LINE
EXTENDS 60'

PHASE II SITE ASSESSMENT
OLYMPIA ALUMINUM
WOBURN, MASS.

DISTRIBUTION OF TOTAL
BTEX COMPOUNDS

SEPT 1989

FIGURE NO. 2

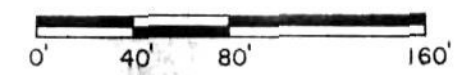


NOTES:

- 1) BASE MAP DEVELOPED FROM PLAN PROVIDED BY JUNIPER DEVELOPMENT CORP. ENTITLED "DETAIL PLAN - WOBURN, MASS." DATED 5/25/83, ORIGINAL SCALE 1"=40'.
- 2) THE LOCATIONS OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY TAPE MEASUREMENTS AND "LINE OF SIGHT" FROM EXISTING TOPOGRAPHIC FEATURES. THESE DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
- 3) REFER TO FIGURE No. 1 FOR ADDITIONAL INFORMATION.

LEGEND:

- (2.07) TOTAL CONCENTRATION OF CHLORINATED VOLATILE ORGANIC COMPOUNDS (TETRACHLOROETHYLENE AND TRICHLOROETHYLENE) (ppm, vol/vol)
- ND INDICATES NO CHLORINATED VOC's DETECTED
- SOIL GAS MONITORING LOCATION



PROPERTY LINE EXTENDS 640'

PHASE II SITE ASSESSMENT
60 OLYMPIA AVENUE
WOBURN, MASS.

DISTRIBUTION OF TOTAL
CHLORINATED VOLATILE
ORGANIC COMPOUNDS

SEPT. 1989

FIGURE No. 3



APPENDIX E
SOIL GAS ANALYTICAL RESULTS AND METHODS

The GEO Building 320 Needham Street Newton Upper Falls, MA 02454
TEL 617 969 0050 FAX 617 965 7769

October 18, 1989
File No. 2-4596.2-C/PC
2-4596-12

Mr. Charles Whitten
Juniper Development Group, Inc.
39 Holton Street
Winchester, Massachusetts 01890

Re: Results of Soil Gas Survey;
Proposed Boring Locations
60 Olympia Avenue
Woburn, Massachusetts
DEQE Case No. 3-594

Dear Mr. Whitten:

Pursuant to our Phase II Scope of Work dated April 14, 1989 and Addendum dated June 5, 1989, Goldberg-Zoino & Associates, Inc. (GZA) has completed a soil gas monitoring program at the 60 Olympia Avenue site in Woburn, Massachusetts. The purpose of the soil gas monitoring program was to further evaluate the areal distribution of volatile organic compounds (VOCs) at the site to aid in the selection of additional boring locations; the work was conducted as part of our Phase II evaluation of the area of the underground storage tanks and fuel pump islands. In accordance with DEP's requirements as set forth in its approval of GZA's Scope of Work, dated June 26, 1989, GZA will submit the results of the soil gas monitoring program, together with proposed boring locations, to DEP for review and approval prior to executing the borings.

SOIL GAS MONITORING

The soil gas monitoring program was conducted by GZA personnel on July 13-14, 1989, in accordance with procedures previously submitted to the DEP and summarized in Appendix A. Twenty-three soil gas monitoring points were installed in a generally rectangular grid pattern in the vicinity of underground tanks located at the site. The pattern was designed to further delineate the extent of petroleum-related compounds in the area, and to identify additional sources of VOCs, if present. Six additional soil gas monitoring points were installed in the vicinity of boring B-4, where trace concentrations of toluene and

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benzene have previously been detected, to provide additional information on the presence and distribution of VOCs. Locations of the soil gas monitoring points are shown on Figure 1. Soil gas monitoring results are tabulated in Appendix B. The data are summarized in Table 1, which presents total BTEX (benzene, toluene, ethyl benzene, and xylenes) concentrations, total chlorinated VOC concentrations (consisting of tetrachloroethylene and trichloroethylene) and total VOC concentrations. Total BTEX concentrations are shown on Figure 2, and total chlorinated VOC concentrations are shown on Figure 3.

SUMMARY OF RESULTS

BTEX compounds were detected at locations in the vicinity of a waste oil tank and in the vicinity of the underground petroleum tanks located at the study site. No BTEX compounds were detected at soil gas monitoring locations to the north of the building, in the vicinity of the fueling island or west of the underground tank toward the Aberjona River. No BTEX compounds were detected in the vicinity of boring B-4. These data indicate limited areal extent of contamination by BTEX compounds and confirm the results of our previous studies.

Chlorinated VOCs were detected over a more extensive area; these compounds were reported in 24 of the 29 samples analyzed. Chlorinated VOCs were generally not reported to the northwest of the existing building. The source(s) of these VOCs have not been identified. A relatively elevated concentration of chlorinated VOCs was detected at SG-17, which may reflect a localized (on-site) source. Although on-site source(s) may exist, at least a portion of these materials may be related to the regional contamination of this portion of Woburn by chlorinated VOCs. Although chlorinated VOCs were generally not detected in GZA's screening of the groundwater samples collected during our 1988 studies at the site, the presence of a large number of unknown petroleum-related VOCs produced complex chromatograms and may have obscured the presence of the chlorinated compounds in the 1988 analyses. (A large number of unknown compounds were detected in a sample from an observation well located in the vicinity of SG-17.)

In summary, the results of the soil gas monitoring program indicate two localized areas of BTEX contamination, apparently related to the present and former petroleum product storage tanks at the site, and a more widespread distribution of chlorinated VOCs from an unknown source(s). No well-defined plume of either type of VOC was identified.

RECOMMENDED BORING LOCATIONS FOR FURTHER STUDY

Based on the results of our soil gas monitoring, we recommend further subsurface explorations south of the underground tank storage area. Proposed boring locations are shown on Figure 4.

Groundwater elevations measured during our earlier work at the site indicated a southerly or southwesterly flow direction. Four additional shallow borings are proposed to the south (the downgradient) of the underground tank areas. The available data indicate that these additional borings may be sufficient to allow delineation of the areal extent of contamination by petroleum products. In addition, two deep borings will be executed in accordance with our Phase II plan. Should visual or olfactory evidence and/or the results of field and/or laboratory screening of soil samples collected during the drilling program indicate the presence of elevated levels of petroleum-related compounds at these locations, the need for additional borings will be re-evaluated.

One of the two proposed deep borings will be located south of the underground tank area, where elevated levels of petroleum-related contaminants have previously been reported; the second deep boring will be located south of the waste oil tank. Groundwater samples from the former boring could also be analyzed to verify the elevated chlorinated VOC detection at SC-17, if the large number of compounds does not obscure the presence of these compounds. Should field screening data indicate that more elevated levels of VOCs are present at other locations, the deep borings may be relocated as appropriate.

NO BTEX compounds were detected north and northwest of the building area or in the vicinity of boring location B-4. Therefore, we do not plan to execute test borings in these locations as anticipated before the soil gas monitoring program and suggested in our Phase II plan.

GZA

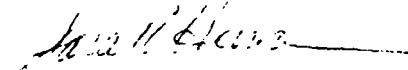
Juniper Development Group, Inc. - October 18, 1989
File No. 2-4596.2 - Page 4

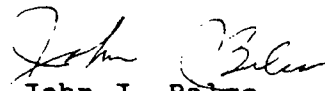
GZA will forward this report to the DEP for review and approval of the proposed boring locations. Please call if you have questions or require further information.

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.


Charles A. Lindberg
Project Reviewer


Sara R. Hanna
Senior Environmental Specialist


John J. Balco
Associate-in-Charge

SRH/JJB:pam
Attachments: Table
Sketches
Appendix A
Appendix B

cc: Ms. Rodene DeRice, Massachusetts DEP

TABLE 1
SOIL GAS RESULTS (PPM-VOL/VOL)
60 Olympia Avenue
Woburn, Massachusetts

<u>Sample No.</u>	<u>Total BTX Compounds</u>	<u>Total Chlorinated VOCs</u>	<u>Total VOCs</u>
SG-1	TR	0.705	0.74
SG-2	2.2	0.429	2.6
SG-3	TR	0.215	0.24
SG-4	0.135	0.54	0.68
SG-5	0.115	0.072	0.19
SG-6	ND	0.037	0.037
SG-7	0.299	0.27	0.57
SG-8	4.18	0.81	5.0
SG-9	0.339	0.34	0.68
SG-10	0.022	0.454	0.48
SG-11	ND	0.28	0.28
SG-12	ND	ND	ND
SG-13	ND	ND	ND
SG-14	ND	0.096	0.096
SG-15	ND	0.39	0.39
SG-16	ND	0.13	0.13
SG-17	ND	18	18
SG-18	ND	0.25	0.25
SG-19	ND	3.1	3.1
SG-20	ND	ND	ND
SG-21	ND	ND	ND
SG-22	ND	0.14	0.14
SG-23	ND	ND	ND
SG-24	ND	2.7	2.7
SG-25	ND	TR	TR
SG-26	ND	ND	ND
SG-27	ND	0.28	0.28
SG-28	ND	0.66	0.66
SG-29	ND	1.7	1.7

Notes:

Samples collected and analyses conducted by GZA personnel on July 13-14, 1989. Refer to Appendix A for a more detailed description of procedures, and to Appendix B for a tabulation of concentrations of individual VOCs.

ND - Not detected above the detection limit.

TR - Trace - below detection limit.

APPENDIX A
SUMMARY OF SOIL GAS MONITORING PROCEDURES

SAMPLING METHODOLOGY:

Soil gas samples are obtained by driving a 4-foot stainless steel probe into the soil, with an electric rotary vibratory hammer or a mechanical slide hammer, to a depth of 3.5 feet. For the samples taken below impermeable surfaces, such as asphalt, the surface is first penetrated with a 1/2-inch diameter spiral carbide bit that attaches to a rotary vibratory hammer. After a probe is inserted into the soil, it is then lifted 6-inches and a 3/16-inch solid rod is inserted into the probe to eject a hardened disposable tip. The sampling zone is, therefore, from 3 to 3.5 feet and this depth can be assumed unless some other depth is specifically stated.

Following probe placement, a three way sampling head is attached to the sampling probe. The head contains a three-way valve which has an off position, a position to connect flow from the probe to a sampling pump, and a third position to connect flow from the probe to a direct luer-lok coupled syringe.

During sampling, the pump effluent is monitored for total VOC's with an HNU PI-101 portable photoionization detector. When the level of total VOCs reaches a stable concentration, a sample of the extracted soil gas is obtained from the probe (via a direct luer lok-coupled syringe) for gas chromatograph (GC) analysis. The probe is removed from the soil and decontaminated after each sample in order to avoid cross-contamination.

ANALYTIC METHODOLOGY:

Soil gas samples were analyzed on a Photovac 10S10 Gas Chromatograph (GC) equipped with heated oven and with a CPSIL-5 capillary column. The data is routed to a battery operated personal computer. The computer converts the data from analog to digital, it plots the data in real time and then stores it for further interpretation.

The instrument is calibrated regularly and the calibration is checked each day of field use. The GC is calibrated for soil gas as follows: A known volume and dilution of the compound of interest is injected into a 500ml. glass bulb. The liquid is allowed to evaporate and mix. An air sample is withdrawn from the bulb and analyzed in a manner identical to that of a sample. Air blanks are run after each contaminated sample to access the level of VOC's in background air and in the syringe. Method blanks are routinely analyzed to control decontamination procedures.

UNITS:

The concentrations are first calculated in units of micrograms per liter and then converted to units of PPM - vol./vol. This conversion assumes that the molar volume of air is 22.4 moles per liter which is based on standard temperature and pressure. The actual temperature and pressure at the sampling location and depth is neither measured in the field nor accounted for in the conversion to PPM - volume/volume.

APPENDIX B
SOIL GAS MONITORING RESULTS

SOIL GAS MONITORING RESULTS
60 OLYMPIA AVENUE

File #: 2-4596.2

Date of Analysis: 7/13/89 & 7/14/89

GZA

320 Needham St.

Newton Upper Falls, MA

02164

GZA SOIL GAS ANALYSIS
(PPM - vol/vol)

Sample Location Depth Compound	SG-1 3 FT.	SG-2 3 FT.	SG-3 3 FT.	SG-4 3 FT.	SG-5 3 FT.	Detection Limit
BENZENE	TR(0.016)	1.8	TR(0.010)	0.025	0.060	0.02
TOLUENE	TR(0.018)	0.40	TR(0.017)	0.11	0.055	0.02
E-BENZENE						0.05
M,P-XYLENE						0.05
O-XYLENE		0.059				0.05
TETRACHLOROETHENE	0.70	0.37	0.15	0.42		0.02
TRICHLOROETHENE	TR(0.005)		0.065	0.12	0.072	0.02
1,1-DICHLOROETHYLENE						0.05
TRANS-1,2-DCE						0.05
CIS-1,2-DCE						0.05
VINYL CHLORIDE						0.5
METHYLENE CHLORIDE						0.1
1,1,1-TRICHLOROETHANE						0.2
1,1-DICHLOROETHANE						0.2
1,2-DICHLOROETHANE						0.5
ETHYL ACETATE						1
ACETONE						0.2
METHYL ETHYL KETONE						0.2
MIBK						0.2
TOTAL COMPOUNDS	0.74	2.6	0.24	0.68	0.19	

NOTATION

ND - Not Detected above the detection limit

TR - Trace, below the detection limit; the identification and quantification are less certain.

DCE - Dichloroethylene

MIBK - Methyl Iso-butyl Ketone

BLANK SPACE - Indicate that the compound was not detected

SOIL GAS MONITORING RESULTS
60 OLYMPIA AVENUE

File #: 2-4596.2
Date of Analysis: 7/13/89 & 7/14/89

GZA
320 Needham St.
Newton Upper Falls, MA
02164

GZA SOIL GAS ANALYSIS
(PPM - vol/vol)

Sample Location Depth Compound	SG-6 3 FT.	SG-7 3 FT.	SG-8 3 FT.	SG-9 3 FT.	SG-10 3 FT.	Detection Limit
BENZENE		0.083	0.080	0.070		0.02
TOLUENE		0.16	1.5	0.099	0.022	0.02
E-BENZENE						0.05
M,P-XYLENE		TR(0.042)	1.6	0.11		0.05
O-XYLENE		TR(0.014)	1.0	0.060		0.05
TETRACHLOROETHENE	0.037	0.27	0.81	0.34	0.45	0.02
TRICHLOROETHENE					TR(0.004)	0.02
1,1-DICHLOROETHYLENE						0.05
TRANS-1,2-DCE						0.05
CIS-1,2-DCE						0.05
VINYL CHLORIDE						0.5
METHYLENE CHLORIDE						0.1
1,1,1-TRICHLOROETHANE						0.2
1,1-DICHLOROETHANE						0.2
1,2-DICHLOROETHANE						0.5
ETHYL ACETATE						1
ACETONE						0.2
METHYL ETHYL KETONE						0.2
MIBK						0.2
TOTAL COMPOUNDS	0.037	0.57	5.0	0.68	0.48	

NOTATION

ND - Not Detected above the detection limit

TR - Trace, below the detection limit; the identification and quantification are less certain.

DCE - Dichloroethylene

MIBK - Methyl Iso-butyl Ketone

BLANK SPACE - Indicates that the compound was not detected

SOIL GAS MONITORING RESULTS
60 OLYMPIA AVENUE

File #: 2-4596.2
Date of Analysis: 7/13/89 & 7/14/89

GZA
320 Needham St.
Newton Upper Falls, MA
02164

GZA SOIL GAS ANALYSIS
(PPM - vol/vol)

Sample Location Depth Compound	SG-11 3 FT.	SG-12 3 FT.	SG-13 3 FT.	SG-14 3 FT.	SG-15 3 FT.	Detection Limit
BENZENE						0.02
TOLUENE						0.02
E-BENZENE						0.05
M,P-XYLENE						0.05
O-XYLENE						0.05
TETRACHLOROETHENE	0.26			0.096	0.31	0.02
TRICHLOROETHENE	TR(0.015)				0.076	0.02
1,1-DICHLOROETHYLENE						0.05
TRANS-1,2-DCE						0.05
CIS-1,2-DCE						0.05
VINYL CHLORIDE						0.5
METHYLENE CHLORIDE						0.1
1,1,1-TRICHLOROETHANE						0.2
1,1-DICHLOROETHANE						0.2
1,2-DICHLOROETHANE						0.5
ETHYL ACETATE						1
ACETONE						0.2
METHYL ETHYL KETONE						0.2
MIBK						0.2
TOTAL COMPOUNDS	0.28	ND	ND	0.096	0.39	

NOTATION

ND - Not Detected above the detection limit
TR - Trace, below the detection limit; the identification and quantification are less certain.
DCE - Dichloroethylene
MIBK - Methyl Iso-butyl Ketone
BLANK SPACE - Indicate that the compound was not detected

SOIL GAS MONITORING RESULTS
60 OLYMPIA AVENUE

File #: 2-4596.2
Date of Analysis: 7/13/89 & 7/14/89

GZA
320 Needham St.
Newton Upper Falls, MA
02164

GZA SOIL GAS ANALYSIS
(PPM - vol/vol)

Sample Location Depth Compound	SG-16 3 FT.	SG-17 3 FT.	SG-18 3 FT.	SG-19 3 FT.	SG-20 3 FT.	Detection Limit
BENZENE						0.02
TOLUENE						0.02
E-BENZENE						0.05
M,P-XYLENE						0.05
O-XYLENE						0.05
TETRACHLOROETHENE	0.13	10	0.17	1.4		0.02
TRICHLOROETHENE		7.8	0.075	1.7		0.02
1,1-DICHLOROETHYLENE						0.05
TRANS-1,2-DCE						0.05
CIS-1,2-DCE						0.05
VINYL CHLORIDE						0.5
METHYLENE CHLORIDE						0.1
1,1,1-TRICHLOROETHANE						0.2
1,1-DICHLOROETHANE						0.2
1,2-DICHLOROETHANE						0.5
ETHYL ACETATE						1
ACETONE						0.2
METHYL ETHYL KETONE						0.2
MIBK						0.2
TOTAL COMPOUNDS	0.13	18	0.25	3.1	ND	

NOTATION

ND - Not Detected above the detection limit

TR - Trace, below the detection limit; the identification and quantification are less certain.

DCE - Dichloroethylene

MIBK - Methyl Iso-butyl Ketone

BLANK SPACE - Indicates that the compound has not been detected

SOIL GAS MONITORING RESULTS
60 OLYMPIA AVENUE

File #: 2-4596.2
Date of Analysis: 7/13/89 & 7/14/89

GZA
320 Needham St.
Newton Upper Falls, MA
02164

GZA SOIL GAS ANALYSIS
(PPM - vol/vol)

Sample Location Depth	SG-21 3 FT.	SG-22 3 FT.	SG-23 3 FT.	SG-24 3 FT.	SG-25 3 FT.	Detection Limit
Compound						
BENZENE						0.02
TOLUENE						0.02
E-BENZENE						0.05
M,P-XYLENE						0.05
O-XYLENE						0.05
TETRACHLOROETHENE		0.13		2.7	TR(0.010)	0.02
TRICHLOROETHENE		TR(0.006)		0.024	TR(0.012)	0.02
1,1-DICHLOROETHYLENE						0.05
TRANS-1,2-DCE						0.05
CIS-1,2-DCE						0.05
VINYL CHLORIDE						0.5
METHYLENE CHLORIDE						0.1
1,1,1-TRICHLOROETHANE						0.2
1,1-DICHLOROETHANE						0.2
1,2-DICHLOROETHANE						0.5
ETHYL ACETATE						1
ACETONE						0.2
METHYL ETHYL KETONE						0.2
MIBK						0.2
TOTAL COMPOUNDS	ND	0.14	ND	2.7	TR(0.022)	

NOTATION

ND - Not Detected above the detection limit

TR - Trace, below the detection limit; the identification and quantification are less certain.

DCE - Dichloroethylene

MIBK - Methyl Iso-butyl Ketone

BLANK SPACE - Indicate that the compound was not detected

SOIL GAS MONITORING RESULTS
60 OLYMPIA AVENUE

File #: 2-4596.2
Date of Analysis: 7/13/89 & 7/14/89

GZA
320 Needham St.
Newton Upper Falls, MA
02164

GZA SOIL GAS ANALYSIS
(PPM - vol/vol)

Sample Location Depth Compound	SG-26 3 FT.	SG-27 3 FT.	SG-28 3 FT.	SG-29 3 FT.	Detection Limit
BENZENE					0.02
TOLUENE					0.02
E-BENZENE					0.05
M,P-XYLENE					0.05
O-XYLENE					0.05
TETRACHLOROETHENE				0.015	0.02
TRICHLOROETHENE		0.28	0.66	1.7	0.02
1,1-DICHLOROETHYLENE					0.05
TRANS-1,2-DCE					0.05
CIS-1,2-DCE					0.05
VINYL CHLORIDE					0.5
METHYLENE CHLORIDE					0.1
1,1,1-TRICHLOROETHANE					0.2
1,1-DICHLOROETHANE					0.2
1,2-DICHLOROETHANE					0.5
ETHYL ACETATE					1
ACETONE					0.2
METHYL ETHYL KETONE					0.2
MIBK					0.2
TOTAL COMPOUNDS	ND	0.28	0.66	1.7	

NOTATION

ND - Not Detected above the detection limit

TR - Trace, below the detection limit; the identification and quantification are less certain.

DCE - Dichloroethylene

MIBK - Methyl Iso-butyl Ketone

BLANK SPACE - Indicates that the compound has not been detected

APPENDIX F
BORING LOGS

GOLDBERG-ZOINO & ASSOCIATES, INC.				PROJECT 60 Olympia Avenue Woburn, Massachusetts				REPORT OF BORING No. GZ-7 SHEET 1 OF 1 FILE No. 4596.2 CHKD. BY																							
CONSULTING ENGINEERS/GEOLOGISTS/ENV. SPECIALISTS				BORING Co. GZA Drilling, Inc. FOREMAN Paul Schaefer/John Pelligrini GZA ENGINEER Nancy Davis/LF				BORING LOCATION See Exploration Location plan GROUND SURFACE ELEVATION DATE START 1/2/90 DATE END 1/2/90																							
SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in. CASING SIZE: OTHER: 3-3/4" HSA				GROUNDWATER READINGS <table border="1"> <thead> <tr> <th>DATE</th> <th>TIME</th> <th>DEPTH</th> <th>CASING</th> <th>STABILIZATION TIME</th> </tr> </thead> <tbody> <tr> <td>01/02/90</td> <td>1130</td> <td>8.5' ±</td> <td>Auger</td> <td>0 Hours</td> </tr> <tr> <td>01/03/90</td> <td>1300</td> <td>6.0'</td> <td>2" PVC</td> <td>1 Day</td> </tr> <tr> <td>01/08/90</td> <td>0900</td> <td>5.92'</td> <td>2" PVC</td> <td>6 Days</td> </tr> </tbody> </table>								DATE	TIME	DEPTH	CASING	STABILIZATION TIME	01/02/90	1130	8.5' ±	Auger	0 Hours	01/03/90	1300	6.0'	2" PVC	1 Day	01/08/90	0900	5.92'	2" PVC	6 Days
DATE	TIME	DEPTH	CASING	STABILIZATION TIME																											
01/02/90	1130	8.5' ±	Auger	0 Hours																											
01/03/90	1300	6.0'	2" PVC	1 Day																											
01/08/90	0900	5.92'	2" PVC	6 Days																											
DEPTH	CASING	BLOWS	SAMPLE			SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING (ppm)	REMARKS																					
			No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"																									
			S-1	24/12	0.8-2.8	11-20	Pavement 0.8'	ASPHALT																							
						26-40	Dense, brown-orange, fine to coarse SAND, little(-) Silt, trace(+) medium to coarse Gravel.	BOULDERY FILL																							
5			S-2	24/15	5-7	8-25	Very dense, brown-orange, fine to coarse SAND, and coarse Gravel, trace(+) Silt.	5' ±																							
						36-78																									
10			S-3	24/15	10-12	4-6	Medium dense, brown-orange, fine to coarse SAND, some(+) coarse Gravel, trace(+) Silt.	SAND																							
						6-6																									
15			S-4	24/22	15-17	18"-WOR	Very loose to loose, gray-brown, fine SAND, little(-) Silt.																								
						4																									
							Bottom of boring at 17 feet																								
20																															
25																															
30																															
35																															
40																															
REMARKS: 1. Field testing data represent total organic vapor levels, referenced to a benzene standard, measured in the headspace of sealed soil sample jars using an H-Nu Model PI-101 photoionization analyzer with a 10.2-eV probe. Results are in parts per million (ppm). ND indicates nothing detected (<0.1 ppm). 2. WOR indicates sampler advanced by weight of drill rods alone.																															
NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.																															
GZA										BORING No. GZ-7																					

GOLDBERG-ZOINO & ASSOCIATES, INC.				PROJECT 60 Olympia Avenue Woburn, Massachusetts				REPORT OF BORING No. GZ-8 SHEET 1 OF 1 FILE No. 5596.2 CHKD. BY			
CONSULTING ENGINEERS/GEOLOGISTS/ENV. SPECIALISTS				BORING Co. GZA Drilling, Inc. FOREMAN Paul Schaefer/John Pettigrint GZA ENGINEER Nancy Davis/LP				BORING LOCATION See Exploration Location plan GROUND SURFACE ELEVATION DATUM DATE START 1/2/90 DATE END 1/2/90			

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in. CASING SIZE: OTHER: 3-3/4" HSA						GROUNDWATER READINGS				
DATE		TIME		DEPTH		CASING		STABILIZATION TIME		
01/02/90		1430		8' ±		Auger		0 Hours		
01/03/90		1330		5.65'		2" PVC		1 Day		
01/08/90		0930		5.53'		2" PVC		6 Days		

DEPTH H	C A S I N G S	B L O W S	SAMPLE				SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING (ppm)	REMARKS	
			No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"						
5			S-1	24/15	0.8-2.8	17-30	Pavement 0.8'	ASPHALT		0.3	1.	
						22-22	Very dense, light brown, fine SAND, little(+) Silt, trace(-) medium Gravel.	FILL				
								5' ±				
			S-2	24/8	5-7	9-11	Medium dense, brown, fine to coarse SAND, little(+) Silt, trace(-) coarse Gravel.	SAND				0.2
10						14-19						
			S-3	24/24	10-12	14-16	Medium dense, light brown, fine SAND, little(+) Silt.		0.3			
15						8-6						
			S-4	24/24	15-17	18-32	Very dense, light brown, fine to medium SAND, little(+) Silt, trace (+) coarse Gravel.		0.4			
20						23-27					2.	
25							Bottom of boring at 17 feet					
30												
35												
40												

REMARKS: 1. See Remark No. 1 on boring log GZ-7.
 2. Sand in augers; blowcounts 15'-17' are not representative.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA
BORING No. GZ-8

GOLDBERG-ZOINO & ASSOCIATES, INC.				PROJECT 60 Olympia Avenue Woburn, Massachusetts				REPORT OF BORING No. <u>GZ-9</u> SHEET <u>1</u> OF <u>1</u> FILE No. <u>4596.2</u> CHKD. BY			
CONSULTING ENGINEERS/GEOLOGISTS/ENV. SPECIALISTS											
BORING Co. <u>GZA Drilling, Inc.</u> FOREMAN <u>Paul Schaefer/John Pettigrint</u> GZA ENGINEER <u>NANCY DAVIS/LP</u>				BORING LOCATION <u>See Exploration Location plan</u> GROUND SURFACE ELEVATION <u>DATUM</u> DATE START <u>1/2/90</u> DATE END <u>1/2/90</u>							

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in. CASING SIZE: OTHER: 3-3/4" HSA					GROUNDWATER READINGS				
DATE	TIME	DEPTH	CASING	STABILIZATION TIME					
01/02/90	1100	6' ±	Auger	0 Hours					
01/03/90	1300	5.34'	2" PVC	1 Day					
01/08/90	1030	5.31'	2" PVC	6 Days					

DEPTH H	C A S I N G S	SAMPLE				SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING (ppm)	REMARKS
		No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"					
5		S-1	24/20	0.8-2.8	34-27	Pavement 0.8'	ASPHALT		0.2	1.
					20-23	Dense, brown, fine SAND, little(+) Silt.	FILL			
							5' ±			
10		S-2	24/20	5-7	7-9	Medium dense, gray, fine SAND, little(+) Silt.	SAND		0.2	
					8-6					
15		S-3	24/20	10-12	14-14	Dense, brown, fine to coarse SAND, little(-) Silt, trace(-) coarse Gravel.			0.3	
					18-16					
20										
25										
30										
35										
40										
Bottom of boring at 13 feet										

REMARKS: 1. See Remark No. 1 on boring log GZ-7.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA
BORING No. GZ-9

GOLDBERG-ZOINO & ASSOCIATES, INC.				PROJECT 60 Olympia Avenue Woburn, Massachusetts				REPORT OF BORING No. GZ-10 SHEET 1 OF 1 FILE No. 4596.2 CHKD. BY			
CONSULTING ENGINEERS/GEOLOGISTS/ENV. SPECIALISTS											
BORING Co. GZA Drilling, Inc.				BORING LOCATION See Exploration Location plan							
FOREMAN PAUL Schaefer/JOHN Pelligrini				GROUND SURFACE ELEVATION DATUM							
GZA ENGINEER Nancy Davis/CT				DATE START 1/2/90				DATE END 1/2/90			

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in. CASING SIZE: OTHER: 3-3/4" HSA						GROUNDWATER READINGS				
DATE	TIME	DEPTH	CASING	STABILIZATION TIME						
01/02/90	0800	5' ±	Auger	0 Hours						
01/03/90	1330	5'	2" PVC	1 Day						
01/08/90	1100	4.76'	2" PVC	6 Days						

DEPTH H	CASING G	B L O W S	SAMPLE				SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING (ppm)	REMARKS	
			No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"						
							Pavement 0.8'/Frozen Ground 0.2'	ASPHALT		Bentonite Outside Box	0.2	1.
			S-1	24/15	1-3	40-34	Very dense, brown, fine to medium SAND, little(-) Silt, trace(-), coarse Gravel.	FILL		Curb box	0.2	
					25-37							
5			S-2	24/18	5-7	11-8						
					6-7							
10			S-3	24/18	10-12	20-23	Dense, brown, fine to coarse SAND, little(+) fine to medium Gravel, little(-) Silt, trace fibrous Peat.	SAND		2" PVC Wellscreen 1'-12'	0.1	
					13-16							
			S-4	24/20	12-14	24-28						
					20-22							
15							Bottom of boring at 14 feet					
20												
25												
30												
35												
40												

REMARKS: 1. See Remark No. 1 on boring log GZ-7.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA
BORING No. GZ-10

GOLDBERG-ZOINO & ASSOCIATES, INC.				PROJECT 60 Olympia Avenue Woburn, Massachusetts				REPORT OF BORING No. GZ-11 SHEET 1 OF 2 FILE No. 5596.2 CHKD. BY			
CONSULTING ENGINEERS/GEOLOGISTS/ENV. SPECIALISTS				BORING LOCATION See Exploration Location plan				GROUND SURFACE ELEVATION DATE START 1/3/90 DATE END 1/4/90			
BORING Co. GZA Drilling Inc. FOREMAN Paul Schaefer/John Pettigiani GZA ENGINEER Nancy Davis/Tr				BORING LOCATION See Exploration Location plan				GROUND SURFACE ELEVATION DATE START 1/3/90 DATE END 1/4/90			

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in. CASING SIZE: 3" OTHER: 3-3/4" HSA						GROUNDWATER READINGS				
		DATE	TIME	DEPTH	CASING	STABILIZATION TIME				
		01/03/90	0700	6' ±	Augers	0 Hours				
		01/04/90	1300	5' ±	Augers	0 Hours				
		01/05/90	0800	5.22'	2" PVC	1 Day				
		01/08/90	1200	5.22'	2" PVC	5 Days				

DEPTH	CASINGS	SAMPLE				SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING (ppm)	REMARKS
		No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"					
						Pavement 0.8'	ASPHALT			
		S-1	24/15	0.8-2.8	28-43	Very dense, brown, fine SAND, little(+) silt.		Filter Sand 0'-3'	0.2	1.
					18-13		FILL	2" PVC Riser 0-54.5'		
5		S-2	24/15	5-7	8-11	Medium dense, brown, fine SAND, little(+) silt.	7' ±	Bentonite Seal 3'-4'	0.3	
					10-13			Filter Sand 4'-6'		
10		S-3	24/12	10-12	12-22	Medium dense, gray-black, fine to medium SAND, little(+) silt, trace(-) fine Gravel.		Bentonite Seal 6'-8'	2.2	2.
					24-19		SAND	Filter Sand 8'-18'		
15		S-4	24/24	15-17	10-8	Medium dense, gray-brown, medium to coarse SAND, little(-) silt, trace(-) fine Gravel.			1.2	3.
					11-28					
20		S-5	24/24	20-22	7-7	18" medium dense, gray, fine SAND and SILT beneath 6" brown, coarse Sand.	20' ±	Bentonite Seal 18-23'	0.4	
					6-7					
25		S-6	24/24	25-27	6-3	Loose, gray, fine SAND and SILT.		Filter Sand 23-38'	0.1	
					4-7		SILTY SAND			
30										
		S-7	24/24	32-34	4-5	Loose, gray, fine SAND and SILT.			0.1	4.
					4-5					
35		S-8	24/24	35-37	WOR-6	Medium dense, gray, fine SAND and SILT.			0.1	5.
					5-5					
40								Bentonite Seal 38-40'		

REMARKS:

1. See Remark No. 1 on boring log GZ-7.
2. Sample S-3 had oily odor and sheen.
3. Sample S-4 had slight oily odor.
4. Sample S-7 32'-34' not 30'-32' due to rods slipping; suspect blow counts.
5. WOR indicates sampler advanced by weight of drill rods alone.

NOTES:

- 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
- 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA
BORING No. GZ-11

[illegible]

REMARKS:

6. Running sand encountered with augers at 45'; flushed hole with ~ 20 gallons of water.
7. Began with 3" casing at 55'.
8. Soil description S-13 based on laboratory sieve analysis.
9. Spoon refusal at 64.6'; casing refusal after pounding with 300 lb./265 times;
rollerbit refusal.

NOTES:

- 2) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL. WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GZA

BORING No. GZ-11

GOLDBERG-ZOINO & ASSOCIATES, INC.				PROJECT 60 Olympia Avenue Woburn, Massachusetts				REPORT OF BORING No. GZ-12 SHEET 1 OF 2 FILE No. 4596.2 CHKD. BY			
CONSULTING ENGINEERS/GEOLOGISTS/ENV. SPECIALISTS				BORING Co. GZA Drilling, Inc. FOREMAN PAUL Schaefer/JOHN Pettigiani GZA ENGINEER Nancy Davis/LP							
				BORING LOCATION See Exploration Location plan GROUND SURFACE ELEVATION DATUM DATE START 1/5/90 DATE END 1/8/90							

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in. CASING SIZE: 3" OTHER: 3-3/4" HSA					GROUNDWATER READINGS				
DATE	TIME	DEPTH	CASING	STABILIZATION TIME					
01/05/90	0730	6' ±	Auger	0 Hours					
01/08/90	1230	5.65'	PVC	3 Days					
01/10/90	0930	5.61'	PVC	5 Days					

DEPTH	CLOGS	SAMPLE				SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING (ppm)	REMARKS
		No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"					
5		S-1	24/15	0.8-2.8	30-60	Pavement 0.8'	ASPHALT	Curb box	0.1	1.
					45-30	Very dense, brown, fine to medium SAND, little(+) Silt, little(-) medium to coarse Gravel, trace(-) boulder fragments.	BOULDERY FILL	Filter Sand 0-3'	0.1	
								2" PVC Riser 0-50'	0.2	
		S-2	24/7	5-7	11-13	Medium dense, brown-orange, medium to coarse SAND, little(-) Silt, trace(-) coarse Gravel.	7' ±	Bentonite Seal 3'-5'	0.2	
10					10-13			Filter Sand 5'-15'	0.2	
		S-3	24/8	10-12	14-21	Dense, brown, medium to coarse SAND, little(-) Silt, trace(-) coarse Gravel.	SAND		0.2	
					17-10					
15									0.2	
		S-4	24/24	15-17	19-40	16" very dense, brown, coarse SAND, little(-) Silt over 8" orange, fine Sand, some(+) Silt.	16' ±	Bentonite Seal 15'-20'	0.2	
					34-28					
20									0.2	2.
		S-5	24/10	20-22	WOR-6	Medium dense, gray, fine SAND and SILT.		Filter Sand 20-34'	0.2	
					7-8					
25									0.2	2.
		S-6	24/24	25-27	WOR-3	Loose, gray, fine SAND and SILT, trace(+) fine Gravel.	SILTY SAND		0.2	
					5-7					
30									0.1	2.
		S-7	24/24	30-32	WOR/12"	Very loose, gray, fine SAND and SILT.			0.1	
					3-5					
35									0.1	
		S-8	24/24	35-37	1-1	Loose, gray, fine SAND and SILT.		Bentonite Seal 34-36'	0.1	
					5-7			Filter Sand 36-46'		
40										

REMARKS: 1. See Remark No. 1 on boring log GZ-7.
 2. WOR indicates sampler advanced by weight of drill rods alone.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GZA
BORING No. GZ-12

GOLDBERG-ZOINO & ASSOCIATES, INC.					PROJECT		REPORT OF BORING No. GZ-12				
CONSULTING ENGINEERS/GEOLOGISTS/ENV. SPECIALISTS					60 Olympia Avenue Woburn, Massachusetts		SHEET 2 OF 2 FILE No. 4596.2 CHKD. BY				
DEPTH H	C REMARKS	B REMARKS	SAMPLE			SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING (ppm)	REMARKS	
			No.	PEN. / REC.	DEPTH (Ft.)						BLOWS/6"
45			S-9	24/24	40-42	WOR-WOR WOR-3	Very loose, gray, fine SAND and SILT.		Filter Sand 36-46'	0.1	2.
50			S-10	24/24	50-52	WOR/24"	Very loose, gray, fine SAND and SILT.	SILTY SAND	Bentonite Seal 46-48' Filter Sand 48-60' 2" PVC Wellscreen 50-60'	0.1	2.
55			S-11	24/24	55-57	WOR/24"	Very loose, gray SILT and fine SAND.			0.1	2. 3.
60							63' ±			0.1	4. 5.
65			S-12	24/6	64-65.7	56-30 80-140/5"	S-12: Very dense, brown, fine to coarse SAND, some(+) Silt, some(-) medium to coarse Gravel, fragments in spoon. Bottom of boring at 65.7 feet	TILL			
70											
75											
80											
85											

REMARKS: 3. Soil description S-11 based on laboratory sieve analysis.
 4. Auger and spoon refusal at 65.7 feet.
 5. Hole collapsed to 60 feet during auger removal.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GZA
BORING No. GZ-12

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS		PROJECT No. 31-000-1-1 Woburn, MA		REPORT OF BORING NUMBER 2- SHEET 1 OF 1 DATE 1-3-85 FILE 7-3526	
		BORING CO. GZA Drilling, Inc. FOREMAN A. Johnson GZA ENGINEER D. Brown/ mlb		BORING LOCATION GROUND ELEV. DATE STARTED 1/8/85 DATE ENDED 1/8/85	

CASING		SAMPLER		GROUNDWATER READINGS			
SIZE: 3 3/4" Hollow Stem Auger	TYPE: Split Spoon	OTHER:		DATE	DEPTH	CASING AT	STABILIZATION TIME
HAMMER: 1b	HAMMER: 140	1b					
FALL: 30"	FALL: 30"						

DEPTH	CAS. BL./FT.	SAMPLE			SAMPLE DESCRIPTION	STRATA CHG. GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.	
		NO	PEN./REC.	DEPTH						BLOWS/6"
		S-1	18/10	5-2	6-23-58	Dense, light brown, medium to fine SAND, trace Silt, with 4" of SAND and fine GRAVEL, trace Silt at bottom (Fill).	FILL	Roadbox	0.2	1
5		S-2	18/11	5-6.5	64-72-52	Very dense, multi-colored, fine GRAVEL and medium to fine SAND, trace Silt.	4" GRAVEL	Bentonite Seal 3'-2'	0.7	
10		S-3	18/12	10-11.5	5-10-12	Medium dense, brown, coarse to fine SAND, trace Silt.	8" SAND	Ottawa Sand to 3'		
15						Bottom of boring at 15'.		1 1/2" PVC Wellscreen 14-4'	1.0	

REMARKS:

- Field testing results represent total organic vapors, referenced to a benzene standard, measured in the headspace of sealed soil sample jars using an HNU Model PI-101 photoionization analyzer. Sample injection size was 10cc. Results in parts per million (ppm). (Field testing completed in GZA's Newton Laboratory.) ND indicates "none detected."

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS			PROJECT NO. 11-101-10 Woburn, MA			REPORT OF BORING NUMBER 11-101-10 SHEET 1 OF 1 DATE 1/8/85 FILE 11-101-10					
BORING CO. GZA Drilling, Inc.			BORING LOCATION								
FOREMAN A. Johnson			GROUND ELEV.								
GZA ENGINEER D. Brown/mlb			DATE STARTED 1/8/85 DATE ENDED 1/8/85								
CASING			SAMPLER			GROUNDWATER READINGS					
SIZE: 3 3/4" Hollow Stem Auger			TYPE: Split Spoon OTHER:			DATE DEPTH CASING AT STABILIZATION TIME					
HAMMER: 140			HAMMER: 140								
FALL: 30"			FALL: 30"								
SAMPLE			SAMPLE DESCRIPTION			EQUIPMENT INSTALLED			FIELD TESTING		
NO. PEN./REC. DEPTH BLOWS/6"											
S-1 18/11 .5-2 8-14-15			Medium dense, light brown, fine SAND, trace Silt (Fill).			Roadbox			0.5		
S-2 18/10 5-6.5 0-1-2			Very loose, black organic SILT, some fine Sand.			Bentonite Seal 1'-2'			<0.1		
S-3 18/6 10-11.5 28-58-68			Very dense, gray, coarse to fine SAND and fine GRAVEL, trace Silt.			1 1/2" PVC Wellscreen 12'-2'			0.3		
S-4			Grav, medium SAND.						0.6		
			Bottom of boring at 15'.								
REMARKS:											
1. Sample taken from sand blown up in auger and spoon.											
2. Refer to note #1 on log B-1.											
NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.											

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS						PROJECT <u>Highway 1A</u>		REPORT OF BORING NUMBER <u>B-1</u>			
						SHEET <u>1</u> OF <u>1</u>		DATE <u>1-9-85</u> FILE <u>7-a-12h</u>			
BORING CO. <u>GZA Drilling, Inc.</u>						BORING LOCATION <u>see plan</u>					
FOREMAN <u>A. Johnson</u>						GROUND ELEV. _____					
GZA ENGINEER <u>Rene Price/mlb</u>						DATE STARTED <u>1/9/85</u> DATE ENDED <u>1/9/85</u>					
CASING						SAMPLER		GROUNDWATER READINGS			
SIZE <u>3 3/4" hollow stem auger</u>						TYPE <u>split spoon</u> OTHER:		DATE DEPTH CARTRIDGE STABILIZATION TIME			
HAMMER <u>lb</u>						HAMMER <u>140 lb</u>					
FALL _____						FALL <u>10"</u>					
DEPTH CAS. BL. /FT. SAMPLE NO. PEN./REC. DEPTH BLOWS/6" SAMPLE DESCRIPTION STRATA CHG COR GEN DES EQUIPMENT INSTALLED FIELD TESTING RMKS											
5 S-1 18/14 0-2 13-26-15 Medium dense, brown, fine SAND, trace silt, (Fill). FILL Roadbox 1.0 1											
5 S-2 18/12 4.5-6.5 8-10-9 Loose, grey, fine SAND, some silt. FINE SAND Bentonite Seal 3'-2' 0.5											
10 S-3 18/18 10-11.5 15-18-25 Medium dense, coarse SAND, little silt. PEAT 10' 0.3											
15 Bottom of boring at 15'. COARSE SAND 15" PVC Well screen 15-5'											
REMARKS: 1. Refer to note #1 on log B-1.											
NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.											

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL / GEOHYDROLOGICAL CONSULTANTS			PROJECT 70 Olympia Ave. Woburn, MA			REPORT OF BORING NUMBER 3-4 SHEET _____ OF _____ DATE 1/9/85 FILE 2-4526		
BORING CO. GZA Drilling, Inc.			BORING LOCATION see plan					
FOREMAN A. Johnson			GROUND ELEV. _____					
GZA ENGINEER Renee Price/ mlb			DATE STARTED 1/9/85			DATE ENDED 1/9/85		

CASING				SAMPLER		GROUNDWATER READINGS			
SIZE		TYPE		OTHER	DATE	DEPTH	CASING AT	STABILIZATION TIME	
3 3/4" Auger		split spoon			1/9	6'	out	on completion	
HAMMER: lb		HAMMER: 140		lb					
FALL: _____		FALL: 30"							

DEPTH	CAS. BL. /FT.	SAMPLE				SAMPLE DESCRIPTION	STRATA CHG. GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
		NO.	PEN./REC.	DEPTH	BLOWS/6"					
	-	S-1	18/6	0.5-2	7-11-9	0-0.5'. GRAVEL FILL. Medium dense, brown, fine SAND, little Silt. (Fill).	FILL	Roadbox	0.2	1
							4'	Bentonite Seal 5'-4'		
5		S-2	18/5	5-6.5	3-3-4	Verv loose, brown, gray, fine SAND, some Silt.	FINE SAND	Ottawa Sand to 5'	0.5	
							2'	1 1/2" PVC Wellscreen 15'4"- 5'4"		
10		S-3	18/15	10-11.5	10-9-12	Loose, brown 8" fine SAND, some Silt. 7" coarse SAND, trace Silt.	PEAT		0.4	
							10.5'			
							COARSE SAND			
15						Bottom of boring at 15'4".				

REMARKS:

1. Refer to note #1 on log B-1.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

[illegible]

CLOSBORG-ZOINO & ASSOCIATES, INC.
50 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
60 Olympia Avenue
Woburn, Massachusetts

REPORT OF BORING NO. GZ-1
SHEET 1 OF 1
FILE NO. 4596.1
CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Dave Anderson
GZA ENGINEER William Morse/aps

BORING LOCATION See location plan.
GROUND SURFACE ELEVATION 100.71' NATUM Un-Site
DATE START 04/08/88 DATE END 04/08/88

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3-3/4" HOLLOW STEM AUGER

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STABILIZATION TIME
04/13/88		5.04'	OUT	5 DAYS
07/05/88		5.75'	OUT	

DEPTH (Feet)	C B A L L O W S	SAMPLE				SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS
		No.	PEN./ REC.	DEPTH (Feet)	BLOWS/6"					
		S-1	24/18	0.8-2.8	5-5 4-4	Loose, light brown, fine SAND, trace fine to coarse Gravel, trace (+) Silt (FILL).	0.8 Asphalt FILL	Concrete Roadbox Bentonite Seal 0.5'-1.5' Filter Sand 1.5'-12'	0.1	1
5		S-2	24/24	5-7	9-10 20-20	Medium dense, gray, fine to medium SAND, little silt.	SAND	1 1/2" PVC Screen 2'-12'	0.9	3
10		S-3	24/24	10-12	19-17 16-11	Dense, black, Organic PEAT over- lying dense, gray, fine to coarse SAND and fine to coarse GRAVEL, trace Silt.	ORGANIC PEAT SAND&GRAVEL		21.0	
						Bottom of boring at 12 feet.				
5										
20										
35										

REMARKS:

- Field testing results represent total organic vapor levels [referenced to a benzene standard measured in the headspace of sealed soil sample jars using H-Mu Model P-101 photo-ionization analysis. Results recorded in parts per million (ppm)]. ND indicates none detected.
- Bentonite seal applied outside roadbox.
- Spoon was saturated at 5 to 7 foot sample depth.

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER
MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-1

GOLDBERG-ZOING & ASSOCIATES, INC.
20 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
60 Olympia Avenue
Woburn, Massachusetts

REPORT OF BORING NO. GZ-2
SHEET 1 OF 1
FILE NO. 85596.1
CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Dave Anderson
GZA ENGINEER William Morse/aps

BORING LOCATION See location plan.
GROUND SURFACE ELEVATION 100.67' DATE START 04/08/88
DATE END 05/08/88

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT
SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb.
HAMMER FALLING 24 in.

CASING SIZE:

OTHER: 3-3/4" HOLLOW STEM AUGER

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STABILIZATION TIME
04/13/88		5.11'	OUT	5 DAYS
07/05/88		5.78'	OUT	

DEPTH FEET	C A S I N G	B L O W S	SAMPLE				STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS
			No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"				
			S-1	24/8	0.8-2.8	4-17 21-15	Dense, gray, fine SAND, some Silt, trace fine to coarse Gravel (FILL).	0.8 Asphalt FILL 5 ±	Concrete Roadbox Bentonite Seal 0.5'-1.5'	1 0.8 2
5			S-2	24/12	5-7	5-6 10-10	Medium dense, gray, fine SAND, trace Silt.	SAND 10 ±	Filter Sand 1.5'-12'	0.2 3
10			S-3	24/24	10-12	16-20 24-20	Dense, gray, fine to coarse SAND and fine to coarse GRAVEL, trace (+) Silt.	SAND & GRAVEL	1 1/2" PVC Screen 2'-12'	0.3
							Bottom of boring at 12 feet.			
15										
20										
25										
30										
35										
40										

REMARKS:

1. Refer to Remark 1, Boring GZ-1.
2. Bentonite seal applied outside roadbox.
3. Spoon was saturated, at 5- to 7-foot sample depth.

NOTES:

- 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
- 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING NO. GZ-2

GOLDBERG-ZOINO & ASSOCIATES, INC.
320 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
60 Olympia Avenue
Woburn, Massachusetts

REPORT OF BORING NO. GZ-3
SHEET 1 OF 1
FILE NO. 85595.1
CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Dave Anderson
GZA ENGINEER William Morse/aps

BORING LOCATION See location plan.
GROUND SURFACE ELEVATION 100.0' DAYLUM On-site
DATE START 04/08/88 DATE END 04/09/88

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3-3/4" HOLLOW STEM AUGER

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STABILIZATION TIME
04/13/88		4.72'	OUT	5 DAYS
07/05/88		5.46'	OUT	

DEPTH FEET	C ASING NO.	B LOWS NO.	SAMPLE			SAMPLE DESCRIPTION <u>Burmister</u> CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS
			No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"				
			S-1	24/4	0.8-2.8	5-10 26-15	0.8 Asphalt FILL	Concrete Roadbox Bentonite Seal 0.5'-1.5' Filter Sand 1.5'-1.5'	2.1	1
5			S-2	24/24	5-7 13-8	Medium dense, black, fine SAND, little Silt.	SAND	1 1/4" PVC Screen 2.5'-12.5'	35.0	2
10			S-3	24/24	10-12 20-20	Medium dense, fine to coarse SAND and fine to coarse GRAVEL, trace (+) Silt.	10 ± SAND & GRAVEL		10.1	3
15						Bottom of boring at 13 feet.				4
20										
25										
30										
35										
40										

REMARKS:

1. Refer to Remark 1, Boring GZ-1.
2. Bentonite seal applied outside roadbox.
3. Split spoon sample was saturated at 5 to 7 feet.
4. Strong petroleum hydrocarbon smell from bottom portion of spoon sample.

NOTES:

- 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
- 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-3

RODBERG-ZOINO & ASSOCIATES, INC.
20 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
60 Olympia Avenue
Woburn, Massachusetts

REPORT OF BORING NO. GZ-4
SHEET 1 OF 1
FILE NO. AGS76.1
CHKD. BY

BORING Co.
FOREMAN
GZA ENGINEER

GZA Drilling, Inc.
Dave Anderson
William Morse/aps

BORING LOCATION See location plan.
GROUND SURFACE ELEVATION 99.50' DATUM on-site
DATE START 04/08/88 DATE END 04/08/88

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

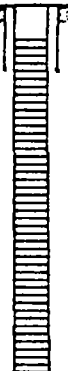
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE:

OTHER: 3-3/4" HOLLOW STEM AUGER

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STABILIZATION TIME
04/13/88		4.45'	OUT	5 DAYS
07/05/88		5.10'	OUT	

DEPTH FEET	C B L O W S	SAMPLE				SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS	
		No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"						
5		S-1	24/24	0.8-2.8	5-9	Medium dense, light brown, fine SAND, little fine to coarse Gravel, trace (+) Silt (FILL). Loose, gray, fine SAND, trace (+) Silt. Loose, brown, organic PEAT.	0.8 Asphalt		Concrete Roadbox Bentonite Seal 0-0.5' Filter Sand 0.5'-1.2'	1.0 0.2 0.3 2.8	1 2 3 4
				10-13	FILL						
		S-2	24/17	5-6.5	8-8		ORGANIC PEAT				
		S-2A		6.5-7	3-2		10 ±				
10		S-3	24/24	10-12	18-20	Dense, gray, fine to coarse SAND and fine to coarse GRAVEL, trace (+) Silt, trace Cobbles.	SAND & GRAVEL				
					23-23						
						Bottom of boring at 12 feet.					
15											
20											
25											
30											
35											
40											

REMARKS:

1. Refer to Remark 1, Boring GZ-1.
2. Bentonite seal applied outside roadbox.
3. Spoon was saturated at the 5- to 7-foot sample.
4. 3 inches of brown organic Peat in bottom of spoon.

NOTES:

- 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
- 2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING NO. GZ-4

GOLDBERG-ZOING & ASSOCIATES, INC.
20 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
60 Olympia Avenue
Woburn, Massachusetts

REPORT OF BORING NO. GZ-5
SHEET 1 OF 1
FILE NO. A5596.1
CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Dave Anderson
GZA ENGINEER William Morse/ADS

BORING LOCATION See location plan.
GROUND SURFACE ELEVATION 99.26' DATUM On-site
DATE START 04/08/88 DATE END 04/08/88

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3-3/4" HOLLOW STEM AUGER

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STABILIZATION TIME
04/13/88		3.78'	OUT	5 DAYS
07/05/88		5.02'	OUT	

DEPTH DOWN FEET	C A S I N G S	SAMPLE				SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS
		No.	PEW./ REC.	DEPTH (Ft.)	BLOWS/6"					
		S-1	24/20	0.8-2.8	10-10 10-17	Medium dense, light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt (FILL).	0.8 Asphalt	Concrete Roadbox	0.3	1
								Bentonite Seal 1'-2'		2
5		S-2	24/24	5-7	12-12 4-3	Loose, light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt overlying loose, gray, very fine Silty SAND.	FILL	Filter Sand 2'-13'	0.7	
							SILTY SAND	1 1/2" PVC Screen 2.5'-12.5'	1.0	3
10		S-3	24/24	10-12	10-17 23-21	Medium dense, fine to coarse SAND and fine to coarse GRAVEL, trace (+) Silt.	10 ±			
							SAND & GRAVEL			
						Bottom of boring at 13 feet.				
15										
20										
25										
30										
35										
40										

REMARKS:
1. Refer to Remark 1, Boring GZ-1.
2. Bentonite seal applied outside roadbox.
3. Spoon was saturated at 5- to 7-foot sample.

NOTES:
1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-5

GOLDENBERG-RODNO & ASSOCIATES, INC.
120 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
60 Olympia Avenue
Woburn, Massachusetts 01801

REPORT OF BORING NO. GZ-6
SHEET 1 OF 1
FILE NO. AG396.1
CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Dave Anderson
GZA ENGINEER WILLIAM MORTSE/ADS

BORING LOCATION See location plan.
GROUND SURFACE ELEVATION 99.37' DATUM On-site
DATE START 04/08/88 DATE END 04/08/88


SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3-3/4" HOLLOW STEM AUGER

GROUNDWATER READINGS

DATE	TIME	DEPTH	CASING	STABILIZATION TIME
04/13/88		4.01'	OUT	5 DAYS
07/05/88		4.99'	OUT	

DEPTH FEET	C A S I N G S	SAMPLE				SAMPLE DESCRIPTION <u>Burmister</u> CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	FIELD TESTING	REMARKS
		No.	PEN./ REC.	DEPTH (Ft.)	BLOWS/6"					
		S-1	24/24	0.3-2.3	5-6 17-18	Medium dense, light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt (FILL).	0.8 Asphalt			1
							FILL			0.2
5		S-2	24/16	5-7	15-13 4-2	Medium dense, light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt overlying gray, very fine SAND, some Silt.	SILTY SAND			0.1
10		S-3	24/24	10-12	17-29 29-49	Very dense, fine to coarse SAND and fine to coarse GRAVEL, trace (+) SILT.	SAND & GRAVEL			0.2
						Bottom of boring at 12 feet.				
15										
20										
25										
30										
35										
40										

REMARKS:
1. Refer to Remark 1, Boring GZ-1.
2. Bentonite seal is outside roadbox.
3. Spoon was saturated at 5- to 7-foot sample.

NOTES:
1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

3ZA

BORING No. GZ-6

APPENDIX G

GZA PID SCREENING METHODS FOR SOIL SAMPLES

GZA TOTAL VOC SCREENING OF SOIL SAMPLES WITH THE HNU MODEL PI-101

OVERVIEW

This method has been developed to rapidly screen soil samples for volatile organic compounds (VOC's) to determine which individual soil samples from multilevel borings or soil test pits should be slated for more rigorous screening by headspace gas chromatography (GC). An HNU Systems Model PI-101 Photoionizer with photo-ionization detection (PID) is employed. The method is frequently subject to false positive and negative responses and, therefore, it is always recommended that at least one sample should be analyzed from each boring by headspace GC for verification. Results from within a particular site may be compared relative to one another, assuming that the nature of contamination is consistent, to develop a depth profile or to define the areal extent of soil contamination.

METHODOLOGY

Soil samples taken in the field are placed in 250ml driller's jars to approximately three quarters full. The samples are stored at four degrees celsius and removed two hours prior to analysis to equilibrate at room temperature. The jars are shaken periodically during this equilibration time to encourage generation of the VOC's into the headspace. Prior to screening, information regarding the site may be submitted to determine which ionization source should be used with the PI-101. For example, sites known to be contaminated with 1,1,1-Trichloroethane should be screened using a PI-101 equipped with an 11.7 eV ionization source at a span setting of 5. Screening at ambient temperatures yields results based on the ionization sensitivity and vapor pressure of the contaminant. Samples are tested by: (1) punching a small hole in the lid of the driller's jar, (2) removing a 30 ml aliquot of the headspace with a glass syringe equipped with an 18 gauge needle, and (3) quickly injecting into the probe extension of the HNU PI-101. The highest meter reading is observed and the background corrected reading is recorded. The instrument is set on the most sensitive scale (0-20) to begin with and, when this scale is exceeded, is progressively set higher to the 0-200 or 0-2000 scale.

CALIBRATION AND QUALITY CONTROL

The HNU PI-101 calibration is checked daily with an internal standard (Isobutylene, chosen for its non-toxicity) that is referenced to Benzene. If the instrument sensitivity fluctuates plus or minus ten percent the instrument is recalibrated. The same procedure is followed for both 10.2eV and 11.7eV instruments. An instrument operation log book is kept to document calibration, maintenance, servicing and battery recharging. Background readings under laboratory conditions should range between 0.3 and 0.7. Background readings beyond this range indicate contamination of the instrument or lab air or that the instrument requires maintenance.

REPORT FORMAT

Samples are formatted on the report according to boring or test pit numbers and sequentially with depth. Air blanks are run subsequent to contaminated samples and results reported. The highest result from each boring group is marked "refrigerator" to indicate that the sample will be stored at four degrees celsius for further analysis. Negative results are reported as "N" and may be due to "clean" air at the site or the presence of a high concentration (percent-level) of a non-ionizable species, such as methane or carbon dioxide. Positive results are reported to two significant digits and are recorded in the appropriate sensitivity column of the format 0-20, 0-200 and 0-2000 ppm. "Off Scale" is recorded when a response scale has been exceeded. Background corrected sample readings less than twice the observed background are not considered significant, i.e. beneath the method detection limit.

DISCLAIMER

Total concentrations of volatile organic compounds determined are semi-qualitative results. The method is designed to yield data for plotting contamination trends only, not as quantitative results. A percentage of each sampling round should be subjected to higher level analysis such as headspace GC screening for verification.

LABORATORY CONTACT PERSON:

Edward W. Pickering
Environmental Chemistry Laboratory Manager
GZA GeoEnvironmental, Inc.
320 Needham Street
Newton Upper Falls, MA 02164
Phone #: (617) 969-0050, x169

REFERENCES

Benoit, E.G. (Deputy Director, Operations. Office of Incident Response. DEQE.), Open letter "...adenda to the Interim Policy for Management of Residuals under M.G.L. Chapter 21E from Spills/Releases of Virgin Petroleum Oils, Jar Headspace Analytical Screening Procedure", (1988).

HNU Systems Inc., Model PI-101 Photoionizer Instruction Manual.

Langhorst, M.L., "Photoionization Detector Sensitivity of Organic Compounds," Paper presented at the 1980 Pittsburgh Conference of Analytical Chemistry and Applied Spectroscopy.

1/91/DM

APPENDIX H

**GZA LABORATORY ANALYTICAL METHODS AND RESULTS
FOR SOIL SAMPLES**

GOLDBERG-ZOINO & ASSOCIATES
370 NEEDHAM STREET
N WTON UPPER FALLS, MA 02164
617) 969-0050

GZA 8240 ANALYSIS
PURGEABLES

PAGE - 1

LAB #: 4596.2
SAMPLE #: GZ-7, S-4
LABORATORY #: A2612S

DATE SAMPLED: 1/2/90
DATE TESTED: 1/3/90
DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST
8240 COMPOUNDS:

	CONCENTRATION ug/kg (PFB)	DETECTION LIMIT ug/kg (PFB)

CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
ETHYLENE CHLORIDE	ND	5

1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5

1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS-1,3-DICHLOROPROPENE	ND	5

1,1,2-TRICHLOROETHANE	--8.4--	5
BROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS-1,3-DICHLOROPROPENE	ND	5

BROMOFORM	ND	5
1,1,1,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHYLENE	--10--	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5

ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	20
1,3-DICHLOROBENZENE	ND	20
1,4-DICHLOROBENZENE	ND	20

SEE PAGE - 2 FOR REMAINING COMPOUNDS

JOB #: 4596.2
SAMPLE #: GZ-7, S-4
LABORATORY #: A2612S

GZA 8240 ANALYSIS
PURGEABLES

PAGE - 2

HAZARDOUS SUBSTANCE LIST 8240 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)

ACETONE	ND	250
CARBON DISULFIDE	ND	5
2-BUTANONE (MEK)	ND	20
ETHYL ACETATE	ND	20
3-HEXANONE (MFK)	ND	20

2-METHYL-2-PENTANONE (MIBK)	ND	20
BTAL XYLENES	ND	5
STYRENE	ND	5

MISCELLANEOUS 240 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)

METHYL-t-BUTYL ETHER	ND	10
TRICHLOROFLOUROMETHANE	ND	20

IDENTIFIED
ON-8240 VOLATILE COMPOUNDS: PROBABILITY

1.
.
.
4.
.

SURROGATES	RECOVERY

1,2-DICHLOROETHANE - D4	102%
TOLUENE - D8	99.5%
p-BROMOFLUOROBENZENE	94.8%

COMMENTS _____

ANALYZED BY ALL AL

REVIEWED BY

KW *fw*

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GZA 8240 ANALYSIS
PURGEABLES

PAGE - 1

JOB #: 4596.2
SAMPLE #: GZ-8, S-2
LABORATORY #: A2630S

DATE SAMPLED: 1/2/90
DATE TESTED: 1/4/90
DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST
(340 COMPOUNDS)

CONCENTRATION DETECTION LIMIT
ug/kg (FPB) ug/kg (FPB)

CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
ETHYLENE CHLORIDE	ND	5

1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5

1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS-1,3-DICHLOROPROPENE	ND	5

1,1,2-TRICHLOROETHANE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS-1,3-DICHLOROPROPENE	ND	5

CHLOROFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHYLENE	ND	5
1,2-DICHLOROBENZENE	ND	5
1,3-DICHLOROBENZENE	ND	5

ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	20
1,3-DICHLOROBENZENE	ND	20
1,4-DICHLOROBENZENE	ND	20

SEE PAGE - 2 FOR REMAINING COMPOUNDS

JOB #: 4596.2
SAMPLE #: GZ-8, S-2
LABORATORY #: A2630S

GZA 8240 ANALYSIS
PURGEABLES

PAGE - 2

HAZARDOUS SUBSTANCE LIST

3240 COMPOUNDS:

	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)

ACETONE	ND	250
CARBON DISULFIDE	ND	5
2-BUTANONE (MEK)	ND	20
ETHYL ACETATE	ND	20
HEXANONE (MPK)	ND	20

METHYL-2-PENTANONE (MIBK)	ND	20
TOTAL XYLENES	ND	5
STYRENE	ND	5

MISCELLANEOUS

40 COMPOUNDS:

	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)

METHYL-t-BUTYL ETHER	ND	10
TRICHLOROFLOUROMETHANE	ND	20

IDENTIFIED

N-8240 VOLATILE COMPOUNDS:

PROBABILITY

SURROGATES

RECOVERY

1,2-DICHLOROETHANE - D4	75.2%
TOLUENE - D8	106%
BROMOFLUOROBENZENE	88.0%

COMMENTS

ANALYZED BY

ALL *ALL*

REVIEWED BY

KW *KW*

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GZA 8240 ANALYSIS
PURGEABLES

PAGE - 1

WOB #: 4596.2
SAMPLE #: GZ-9, S-1
LABORATORY #: A26315

DATE SAMPLED: 1/2/90
DATE TESTED: 1/4/90
DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST
8240 COMPOUNDS:

CONCENTRATION
ug/kg (PPB) DETECTION LIMIT
ug/kg (PPB)

CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
ETHYLENE CHLORIDE	ND	5

1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5

1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
1,1-DIBROMOETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS-1,3-DICHLOROPROPENE	ND	5

1,1-DICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS-1,3-DICHLOROPROPENE	ND	5

CHLOROFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHYLENE	ND	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5

ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	20
1,3-DICHLOROBENZENE	ND	20
1,4-DICHLOROBENZENE	ND	20

SEE PAGE - 2 FOR REMAINING COMPOUNDS

JOB #: 4596.2
SAMPLE #: GZ-9, S-1
LABORATORY #: A2631S

GZA 8240 ANALYSIS
PURGEABLES

PAGE - 2

HAZARDOUS SUBSTANCE LIST
3240 COMPOUNDS:

	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)

1. ETONE	ND	250
2. CARBON DISULFIDE	ND	5
3. 2-BUTANONE (MEK)	ND	20
4. VINYL ACETATE	ND	20
5. 2-HEXANONE (MPK)	ND	20

6. 3-METHYL-2-PENTANONE (MIBK)	ND	20
7. TOTAL XYLENES	ND	5
8. STYRENE	ND	5

MISCELLANEOUS

8. 40 COMPOUNDS:	CONCENTRATION ug/kg (PPB)	DETECTION LIMIT ug/kg (PPB)

1. METHYL-t-BUTYL ETHER	ND	10
2. TRICHLOROFLOUROMETHANE	ND	20

IDENTIFIED

9. N-8240 VOLATILE COMPOUNDS:	PROBABILITY

1.	
2.	
3.	
4.	
5.	

SURROGATES

	RECOVERY

1,2-DICHLOROETHANE - D4	56.1%
TOLUENE - D8	89.8%
4-BROMOFLUOROBENZENE	90.6%

COMMENTS

ANALYZED BY

ALL AU

REVIEWED BY

KW *KW*

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GZA 8240 ANALYSIS
PURGEABLES

PAGE - 1

JOB #: 4596.2
SAMPLE #: GZ-10, S-3
LABORATORY #: A2632S

DATE SAMPLED: 1/2/90
DATE TESTED: 1/4/90
DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST
(240 COMPOUNDS:

CONCENTRATION
ug/kg (PPB)

DETECTION LIMIT
ug/kg (PPB)

CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
ETHYLENE CHLORIDE	ND	5

1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5

1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
1,1-DIBROMOETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS-1,3-DICHLOROPROPENE	ND	5

1,2-DICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS-1,3-DICHLOROPROPENE	ND	5

CHLOROFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHYLENE	ND	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5

ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	20
1,3-DICHLOROBENZENE	ND	20
1,4-DICHLOROBENZENE	ND	20

SEE PAGE - 2 FOR REMAINING COMPOUNDS

JOB #: 4596.2
SAMPLE #: GZ-10, S-3
LABORATORY #: A2632S

GZA 8240 ANALYSIS
PURGEABLES

PAGE - 2

HAZARDOUS SUBSTANCE LIST
8240 COMPOUNDS:

CONCENTRATION
ug/kg (PPB) DETECTION LIMIT
ug/kg (PPB)

ACETONE ND 250
CARBON DISULFIDE ND 5
2-BUTANONE (MEK) ND 20
VINYL ACETATE ND 20
2-HEXANONE (MPK) ND 20

4-METHYL-2-PENTANONE (MIBK) ND 20
MIXED XYLENES ND 5
STYRENE ND 5

MISCELLANEOUS
8240 COMPOUNDS:

CONCENTRATION
ug/kg (PPB) DETECTION LIMIT
ug/kg (PPB)

METHYL-t-BUTYL ETHER ND 10
TRICHLOROFLOUROMETHANE ND 20

IDENTIFIED

NON-8240 VOLATILE COMPOUNDS:

PROBABILITY

1.
2.
3.
4.
5.

SURROGATES

RECOVERY

1,2-DICHLOROETHANE - D4 79.9%
TOLUENE - D8 94.6%
4-BROMOFLUOROBENZENE 76.0%

COMMENTS

ANALYZED BY

ALL ALL

REVIEWED BY

KW *KW*

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GZA 8240 ANALYSIS
PURGEABLES

PAGE - 1

WB #: 4596.2
SAMPLE #: GZ-11, S-3
LABORATORY #: A2634S

DATE SAMPLED: 1/2/90
DATE TESTED: 1/4/90
DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST
1340 COMPOUNDS:

CONCENTRATION
ug/kg (PFB) DETECTION LIMIT
ug/kg (PFB)

CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
ETHYLENE CHLORIDE	ND	5

1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	--13--	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5

1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS-1,3-DICHLOROPROPENE	ND	5

1,1-DICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	--13--	5
CIS-1,3-DICHLOROPROPENE	ND	5

CHLOROFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHYLENE	ND	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5

ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	20
1,3-DICHLOROBENZENE	ND	20
1,4-DICHLOROBENZENE	ND	20

SEE PAGE - 2 FOR REMAINING COMPOUNDS

JOB #: 4596.2
SAMPLE #: GZ-11, S-3
LABORATORY #: A2634S

GZA 8240 ANALYSIS
PURGEABLES

PAGE - 2

HAZARDOUS SUBSTANCE LIST
8240 COMPOUNDS:

CONCENTRATION
ug/kg (PPB) DETECTION LIMIT
ug/kg (PPB)

ACETONE ND 250
CARBON DISULFIDE ND 5
2-BUTANONE (MEK) ND 20
ETHYL ACETATE ND 20
2-HEXANONE (MPK) ND 20

2-METHYL-2-PENTANONE (MIBK) ND 20
TOTAL XYLENES ND 5
STYRENE ND 5

MISCELLANEOUS
8240 COMPOUNDS:

CONCENTRATION
ug/kg (PPB) DETECTION LIMIT
ug/kg (PPB)

METHYL-t-BUTYL ETHER ND 10
TRICHLOROFLOUROMETHANE ND 20

IDENTIFIED

8240 VOLATILE COMPOUNDS:

PROBABILITY

1.
4.

SURROGATES

RECOVERY

1,2-DICHLOROETHANE - D4 78.5%
TOLUENE - D8 93.1%
BROMOFLUOROBENZENE 71.0%

COMMENTS

ANALYZED BY

ALLAN

REVIEWED BY

KW *KW*

GZA EPA METHOD 8240 ANALYSIS

OVERVIEW

EPA Method 8240 is a purge and trap gas chromatographic method for the identification and quantification of volatile halocarbons and volatile aromatics in aqueous samples. Purge and trap is a dynamic headspace technique where volatiles in an aqueous/solid sample are completely stripped from the aqueous/solid phase to the vapor phase. The volatiles from the depleted sample are collected on an absorbent trap, thermally desorbed to a gas chromatograph for separation, and routed to a mass spectrometer.

METHODOLOGY

A Tekmar Model LSC-2000 Liquid Sample Concentrator is used in conjunction with a Tekmar Model ALS 2016 Automatic Laboratory Sampler to purge volatile compounds by bubbling helium gas through a 5 ml aqueous/solid sample and passing the vapor through a tenax/silica gel sorbent trap. The purgeable compounds retained on the trap are then thermally desorbed and passed through a heated line into the gas chromatograph. GZA performs this method on a Hewlett-Packard HP 5890A Gas Chromatograph interfaced to a Hewlett-Packard HP 5970B Mass Selective Detector. Response data are acquired by a Hewlett Packard HP 1000 RTE A Series Micro 24 System with Aquarius data acquisition software. The information for the report is entered manually onto a Lotus Symphony spreadsheet. Calibration and quality control are performed in accordance with the protocols established by the EPA and published in the references cited below.

REPORT FORMAT

The quantitation limit is stated for every report and is adjusted when dilutions are made to bring sample response data within the calibrated range of the method. Concentrations less than the quantitation limit may be identified as "Trace".

DISCLAIMER

Identities and concentrations of purgeable halocarbons and purgeable aromatics by this dynamic headspace technique are subject to limitations inherent to these methods.

LABORATORY CONTACT PERSON: Edward W. Pickering
Environmental Chemistry Laboratory Manager
Phone #: (617) 969-0050, x169.

REFERENCES

McNally, M.E. and R.L. Grob, "A review: Current applications of static and dynamic headspace analysis: Part one: Environmental applications", Am. Lab. 20 (1) 20-33, (1985).

U.S. EPA, "Test methods for evaluating solid waste, physical/chemical methods", SW- 846, Method 8240, GC/MS for Volatile Organics Third Edition Update, (1/89).

APPENDIX I

**CONTRACT LABORATORY ANALYTICAL METHODS AND RESULTS
FOR GROUNDWATER AND SURFACE WATER SAMPLES**



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824

Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120634

ACCOUNT #
000504

CODE PAGE #
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (B1)
60 OLYMPIA AVE
PHASE II
N.D.

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/17/90
00:00		

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
-------	---------	-------	-----------------	--------

*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	ND	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLOROBENZENE	ND	UG/L
TRICHLOROETHENE	ND	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	ND	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLOROBENZENE	ND	UG/L
O-DICHLOROBENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	ND	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	ND	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	ND	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	0.7	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

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4596.2 (B1)



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Mass. Cert. No. 313 * Conn. Cert. No. PH-0515 * EPA ID No. MA059

WCL ID #
00120634

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

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PHASE II
N.D.

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320 NEEDHAM ST.

COLLECTED **RECEIVED** **REPORTED**
01/10/90 01/12/90 01/17/90
00:00

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



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WCL ID #
00120637

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (B2A)
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ND

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01/10/90 00:00	01/12/90	01/24/90

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	287		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	0.5		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	4.1		UG/L	
CIS-1,2-DICHLOROETHENE	67.7		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (B2A)



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HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #

111636

ACCOUNT #

000514

CODE PAGE #

501 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (B4)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED

RECEIVED

REPORTED

01/10/90 01/12/90 01/18/90
00:00

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	5.3		UG/L	
P-XYLENE	SEE NOTE		UG/L	
P-XYLENE AND M-XYLENE = 1.3 UG/L.				
COELUTION PROHIBITS SEPARATION.				
O-XYLENE	0.6		UG/L	
M-XYLENE	SEE NOTE		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3131 Conn Cert No PH-0515 EPA D No MA059

WCL ID #
00120648

ACCOUNT #
000504

CODE PAGE #
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ1)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90 00:00	01/12/90	01/19/90

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
-------	---------	-------	-----------------	--------

*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	34	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLOROBENZENE	ND	UG/L
TRICHLOROETHENE	0.7	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	1.2	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLOROBENZENE	ND	UG/L
O-DICHLOROBENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	0.7	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	ND	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	9.4	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	0.6	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

CONTINUED ON NEXT PAGE

4596.2 (GZ1)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA C No MA059

WCL ID #
00120651

ACCOUNT #
000504

CODE PAGE #
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ1 DUP)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/19/90
00:00		

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
-------	---------	-------	-----------------	--------

*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	40.4	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLOROBENZENE	ND	UG/L
TRICHLOROETHENE	0.7	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	1.1	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLOROBENZENE	ND	UG/L
O-DICHLOROBENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	0.7	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	ND	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	12.5	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	ND	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

CONTINUED ON NEXT PAGE

4596.2 (GZ1 DUP)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Cont Cert No PH-0515 * EPA D No MAC59

WCL ID #
00120651

ACCOUNT #
000504

CODE **PAGE #**
501 3

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ1 DUP)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/19/90
00:00		

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	4.9		UG/L	
P-XYLENE	SEE NOTE		UG/L	
P-XYLENE AND M-XYLENE = 31.3 UG/L.				
COELUTION PROHIBITS SEPARATION.				
O-XYLENE	28.3		UG/L	
M-XYLENE	SEE NOTE		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	2.7		UG/L	
P-ISOPROPYLTOLUENE	0.7		UG/L	
NAPTHALENE	3.0		UG/L	
N-PROPYLBENZENE	5.8		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	1.4		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	14		UG/L	
135 TRIMETHYLBENZENE	2.3		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120840

ACCOUNT #
000504

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E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ2)
60 OLYMPIA AVE
PHASE II
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GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/22/90
00:00		

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	1.2		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	0.5		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

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4596.2 (GZ2)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA D No MA059

WCL ID #

00120643

ACCOUNT #

000604

CODE PAGE #

201 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (G22)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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01/12/90

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01/22/90

00:00

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	0.7		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	1.5		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	0.6		UG/L	
N-PROPYLBENZENE	1.3		UG/L	
SEC-BUTLYBENZENE	0.6		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3131 Conn Cert No PH 0515 EPA D No MA059

WCL ID #

00120644

ACCOUNT #

000504

CODE PAGE #

001

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ3)
60 OLYMPIA AVE
PHASE II
ND

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GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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01/12/90

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01/18/90

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
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*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	TRACE	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLOROBENZENE	ND	UG/L
TRICHLOROETHENE	1.1	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	ND	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLOROBENZENE	ND	UG/L
O-DICHLOROBENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	TRACE	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	ND	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	ND	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	1.4	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

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4596.2 (GZ3)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH 0515 * EPA C No MA059

WCL ID #

00120644

ACCOUNT #

000504

CODE PAGE #

501 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ3)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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01/10/90 01/12/90 01/18/90
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REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA C No MA059

WCL ID #

00120682

ACCOUNT #

000104

CODE PAGE #

501 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ3 DUP)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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01/10/90 01/12/90 01/18/90
00:00

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
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*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	0.5	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLORO BENZENE	ND	UG/L
TRICHLOROETHENE	1.9	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	ND	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLORO BENZENE	ND	UG/L
O-DICHLORO BENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	ND	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	ND	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	ND	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	2.3	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

CONTINUED ON NEXT PAGE

4596.2 (GZ3 DUP)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #

00120651

ACCOUNT #

000504

CODE PAGE #

501

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ3 DUP)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED

01/10/90 01/12/90 01/18/90
00:00

RECEIVED

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REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 Conn Cert No PH-0515 EPA CAC MA053

WCL ID #
00120646

ACCOUNT #
000504

CODE **PAGE #**
301 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ4)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90 00:00	01/12/90	01/18/90

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	0.6		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	18.5		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (GZ4)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 • Conn Cert No PH-0515 • EPA ID No MA059

WCL ID #
00120646

ACCOUNT #
000504

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B01 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (G24)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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01/10/90 00:00	01/12/90	01/18/90

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #

07103647

ACCOUNT #

000804

CODE

001

PAGE #

1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ5)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED

01/10/90

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01/12/90

REPORTED

01/22/90

00:00

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-DICHLOROETHENE	ND		UG/L	
CIS-12DICHLOROETHENE	2.0		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2TRICHLOROETHANE	ND		UG/L	
1112TETRACHLORETHANE	ND		UG/L	
1122-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
123-TRICHLOROPROPANE	ND		UG/L	

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4596.2 (GZ5)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3131 Conn Cert No PH-0515 EPA D No MA059

WCL ID #
00110847

ACCOUNT #
000504

CODE #
E01

SAMPLE IDENTIFICATION INFORMATION

4506.2 (GZ5)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/22/90
00:00		

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	2.7		UG/L	
P-XYLENE	SEE NOTE		UG/L	
P-XYLENE AND M-XYLENE = 1.6 UG/L.				
COELUTION PROHIBITS SEPARATION.				
O-XYLENE	0.7		UG/L	
M-XYLENE	SEE NOTE		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA053

WCL ID #
00120645

ACCOUNT #
000504

CODE **PAGE #**
301 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ6)
60 OLYMPIA AVE
PHASE II
ND

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GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
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REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	2.7		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROETHANE	ND		UG/L	
TRICHLOROETHENE	1.7		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	2.5		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROETHANE	ND		UG/L	
O-DICHLOROETHANE	ND		UG/L	
TRANS-1,2-DICHLOROETHANE	2.2		UG/L	
CIS-1,2-DICHLOROETHANE	318		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

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4596.2 (GZ6)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3131 Conn Cert No PH-0515 EPA ID No MA059

WCL ID #

00120645

ACCOUNT #

000504

CODE PAGE #

EC1 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ6)
60 OLYMPIA AVE
PHASE II
ND

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GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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REPORTED

01/10/90 01/12/90 01/18/90
00:00

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 • Conn Cert No PH-05-5 • EPA D No MA059

WCL ID #
00120641

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ7)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/19/90
00:00		

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	4.1		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	1.7		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	2.1		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	43.4		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (GZ7)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON MA 01748
508-435-6824
Mass Cert No 313 * Contr. Cert No PH 0515 * EPA D No MA034

WCL ID #
00120641

ACCOUNT #
000504

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E01 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ7)
60 OLYMPIA AVE
PHASE II
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GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/19/90
00:00		

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3131 Conn Cert No PH-0515 EPA D No MA053

WCL ID #
00120639

ACCOUNT #
000504

CODE **PAGE #**
EC1 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ9)
60 OLYMPIA AVE
PHASE II
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GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
01/10/90 00:00	01/12/90	01/17/90

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	1.0		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	ND		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

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4596.2 (GZ9)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA053

WCL ID #
00120639

ACCOUNT #
000504

CODE **PAGE #**
E01 2

SAMPLE IDENTIFICATION INFORMATION
4596.2 (GZ9)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED **RECEIVED** **REPORTED**
01/10/90 01/12/90 01/17/90
00:00

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	0.5		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	0.7		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

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WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3-3 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120638

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ10)
60 OLYMPIA AVE
PHASE II
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00:00		

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
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*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	1.1	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLOROBENZENE	ND	UG/L
TRICHLOROETHENE	ND	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	ND	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLOROBENZENE	ND	UG/L
O-DICHLOROBENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	ND	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	ND	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	ND	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	TRACE	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

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4596.2 (GZ10)



WATER CONTROL LABORATORIES
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106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA C No MA059

WCL ID #
00100638

ACCOUNT #
000504

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011 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ10)
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320 NEEDHAM ST.

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REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	1.2		UG/L	
P-XYLENE	SEE NOTE		UG/L	
P-XYLENE AND M-XYLENE = 0.8 UG/L.				
COELUTION PROHIBITS SEPARATION.				
O-XYLENE	TRACE		UG/L	
M-XYLENE	SEE NOTE		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

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WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
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Mass Cert No 3131 Contr Cert No PH-0515 EPA D No MA059

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00120649

ACCOUNT #
000504

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EC1 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ11)
60 OLYMPIA AVE
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320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	2.1		UG/L	
1,2-DICHLOROETHANE	0.5		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	17.2		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	1.3		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	3.6		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	9.2		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	0.5		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

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4596.2 (GZ11)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120650

ACCOUNT #
000504

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E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ12)
60 OLYMPIA AVE
PHASE II
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320 NEEDHAM ST.

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NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	0.6		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	3.3		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	2.5		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	1.3		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	1.8		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	TRACE		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	15.1		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (GZ12)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120650

ACCOUNT #
000504

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E01 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (GZ12)
60 OLYMPIA AVE
PHASE II
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320 NEEDHAM ST.

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01/10/90	01/12/90	01/19/90
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NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	1.6		UG/L	
P-XYLENE	SEE NOTE		UG/L	
P-XYLENE AND M-XYLENE = 1.7 UG/L.				
COELUTION PROHIBITS SEPARATION.				
O-XYLENE	0.8		UG/L	
M-XYLENE	SEE NOTE		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBEZENE	ND		UG/L	
124 TRICHLOROBEZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

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WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA259

WCL ID #

00110683

ACCOUNT #

000504

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501 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (SW1)
60 OLYMPIA AVE
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320 NEEDHAM ST.

NEWTON UPPER FALL, MA

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01/10/90 01/12/90 01/22/90
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FINAL REPORT

COMMENT:

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TESTS

RESULTS

UNITS

DETECTION LIMIT

METHOD

*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	ND	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLOROBENZENE	ND	UG/L
TRICHLOROETHENE	1.7	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	ND	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLOROBENZENE	ND	UG/L
O-DICHLOROBENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	1.9	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	0.5	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	ND	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	ND	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

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4596.2 (SW1)



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508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120684

ACCOUNT #
000504

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E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (SW2)
60 OLYMPIA AVE
PHASE II
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01/10/90	01/12/90	01/22/90
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NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
-------	---------	-------	-----------------	--------

*** GENERAL INFORMATION
COLLECTOR: GZA

*** VOLATILE ORGANICS (524.2)

BENZENE	ND	UG/L
CARBON TETRACHLORIDE	ND	UG/L
1,1-DICHLOROETHENE	ND	UG/L
1,2-DICHLOROETHANE	ND	UG/L
PARA DICHLOROBENZENE	ND	UG/L
TRICHLOROETHENE	1.8	UG/L
111-TRICHLOROETHANE	ND	UG/L
VINYL CHLORIDE	ND	UG/L
BROMOBENZENE	ND	UG/L
BROMODICHLOROMETHANE	ND	UG/L
BROMOFORM	ND	UG/L
BROMOMETHANE	ND	UG/L
CHLOROBENZENE	ND	UG/L
CHLORODIBROMOMETHANE	ND	UG/L
CHLOROETHANE	ND	UG/L
CHLOROFORM	ND	UG/L
CHLOROMETHANE	ND	UG/L
O-CHLOROTOLUENE	ND	UG/L
P-CHLOROTOLUENE	ND	UG/L
DIBROMOMETHANE	ND	UG/L
M-DICHLOROBENZENE	ND	UG/L
O-DICHLOROBENZENE	ND	UG/L
TRANS-1,2-DICHLOROETHENE	ND	UG/L
CIS-1,2-DICHLOROETHENE	1.9	UG/L
DICHLOROMETHANE	ND	UG/L
1,1-DICHLOROETHANE	0.6	UG/L
1,1-DICHLOROPROPENE	ND	UG/L
1,3-DICHLOROPROPENE	ND	UG/L
1,2-DICHLOROPROPANE	ND	UG/L
2,2-DICHLOROPROPANE	ND	UG/L
ETHYLBENZENE	ND	UG/L
STYRENE	ND	UG/L
1,1,2-TRICHLOROETHANE	ND	UG/L
1,1,2-TETRACHLOROETHANE	ND	UG/L
1,1,2,2-TRICHLOROETHANE	ND	UG/L
TETRACHLOROETHENE	ND	UG/L
1,2,3-TRICHLOROPROPANE	ND	UG/L

CONTINUED ON NEXT PAGE

4596.2 (SW2)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120684

ACCOUNT #
000504

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B01 3

SAMPLE IDENTIFICATION INFORMATION

4596.2 (SW2)
60 OLYMPIA AVE
PHASE II
ND

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320 NEEDHAM ST.

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01/10/90	01/12/90	01/22/90
00:00		

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHOLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

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WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Contr Cert No PH-0515 * EPA ID No MA059

WCL ID #

00120655

ACCOUNT #

000604

CODE PAGE #

511 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (SW2 DUP)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED

01/10/90

00:00

RECEIVED

01/12/90

REPORTED

01/18/90

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	1.7		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	1.8		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	0.6		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (SW2 DUP)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Contr Cert No PH-0515 * EPA D No MA054

WCL ID #

00120655

ACCOUNT #

000504

CODE PAGE #

E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (SW2 DUP)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED

01/10/90

00:00

RECEIVED

01/12/90

REPORTED

01/18/90

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00120656

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (TB)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/17/90
00:00		

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	ND		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (TB)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA D No MA059

WCL ID #
00120656

ACCOUNT #
000504

CODE **PAGE #**
EC1 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (TB)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90 00:00	01/12/90	01/17/90

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L	0.0	

ND = LESS THAN THE DETECTION LIMIT INDICATED.

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WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 Conn Cert No PH-0515 EPA D No MA-059

WCL ID #
00120657

ACCOUNT #
000504

CODE PAGE #
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (FB)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/19/90
00:00		

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	ND		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (FB)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3131 Conn Cert No PH-0515 EPA ID No MA059

WCL ID #
00120657

ACCOUNT #
000504

CODE **PAGE #**
E01 2

SAMPLE IDENTIFICATION INFORMATION
4596.2 (FB)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED **RECEIVED** **REPORTED**
01/10/90 01/12/90 01/19/90
00:00

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	ND		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824

Mass Cert No 313 * Conn Cert No PH-0515 * EPA/C No MA059

WCL ID #
00120658

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (BB)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/19/90
00:00		

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	ND		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	ND		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TRICHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (BB)



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA054

WCL ID #
00120658

ACCOUNT #
000504

CODE **PAGE #**
E01 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (BB)
60 OLYMPIA AVE
PHASE II
ND

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
01/10/90	01/12/90	01/19/90
00:00		

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	0.8		UG/L	
P-XYLENE	SEE NOTE		UG/L	
P-XYLENE AND M-XYLENE = 0.6 UG/L.				
COELUTION PROHIBITS SEPARATION.				
O-XYLENE	ND		UG/L	
M-XYLENE	SEE NOTE		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	ND		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	ND		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	0.5	UG/L		

ND = LESS THAN THE DETECTION LIMIT INDICATED.

*** THIS IS A FINAL REPORT. ***

Sample I.D.	Time (24 hr.)	Bailer #	Collector's Initials	Location Description	Sample Type	ANALYSES REQUIRED										Total # of Cont.	Notes		
						VOA 824	VOA 801	VOA 802	ASV 825	PESTPCB	P.P. METAL	ICP-AES	E.P. TOX	PHC-IR	ENGRPRINT			VOC M-X	
B-1			N/D	see plan	Water												3		
B-5																	3		
B-4																	3		
B-2A																	3		
GZ-10																	3		
GZ-9																	3		
GZ-8																	3		
GZ-7																	3		
B-3A																	3		
GZ-2																	3		
GZ-3																	3		
GZ-6																	3		
GZ-4																	3		
GZ-5																	3		
TOTAL NUMBER OF CONTAINERS																	42		
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)						NOTES: Samples collected in triplicate													
Nancy M. Davis 1/12/90 9am S. Carter																			
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)																			
Debra Badra 1/12/90 J. Felt																			
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)																			
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)																			
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)																			
ANALYTICAL LABORATORY: Water Control PHONE:						GZA FILE NO. 4596.2 PO. NO. 1-6601													
LABORATORY CONTACT:						PROJECT 60 Olympia Ave Phase II Study													
GZA CONTACT: S. Hanna / N. Davis EXT.: 157/387						LOCATION Woburn, MA													
Goldberg-Zoino & Associates, Inc. The GEO Building 320 Needham Street NEWTON UPPER FALLS, MA 02164 Phone: 617-969-0050 Fax: 617-965-7769						COLLECTOR(S) N. Davis													
						DATE(S) OF COLLECTION 1/9/90 - 1/10/90 SHEET 1 OF 2													

CHAIN-OF-CUSTODY RECORD

Sample I.D.	Time (24 hr.)	Bailer #	Collector's Initials	Location Description	Sample Type	ANALYSES REQUIRED												Total # of Cont.	Note #
						VOA 624	VOA 801	VOA 802	ABN 825	PEST/PCB	PP. METAL	PCRA-B	E.P. TOX.	PHC/IR	ENG/PRINT	Me H	324 VOCs		
GZ-1'			ND	see plan	water											3	3		
GZ-11																3	3		
GZ-12																3	3		
GZ-1 DUP																3	3		
GZ-3 DUP																3	3		
Sw-1																3	3		
Sw-2																3	3		
Sw-2 DUP																3	3		
TB																3	3		
FB																3	3		
BB																3	3		
TOTAL # from p. 1															42	42			
TOTAL NUMBER OF CONTAINERS																75	75		
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)						NOTES: Samples collected in triplicate DUP = Duplicate													
Nancy M. Davis 1/12/90 9am A. Carter																			
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)																			
Leela Badran 1/12/90 J. Zillo																			
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)																			
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)																			
ANALYTICAL LABORATORY: Water Control PHONE: _____						GZA FILE NO. 4596.2 PO. NO. 1-6601													
LABORATORY CONTACT: _____						PROJECT 60 Olympia Ave Phase II Study													
GZA CONTACT: B. Hanna / N. Davis EXT. 157/387						LOCATION Woburn MA													
Goldberg-Zoino & Associates, Inc. The GEO Building 320 Needham Street NEWTON UPPER FALLS, MA 02164 Phone: 617-969-0050 Fax: 617-965-7769						COLLECTOR(S) N. Davis													
						DATE(S) OF COLLECTION 1/9/90-1/10/90 SHEET 2 OF 2													



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 3*3* Conc Cert No PH-0515*EPA D No MA059

WCL ID #
00853894

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.20 (MW1)
60 OLYMPIA AVE
WOBURN
N. DAVIS

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED **RECEIVED** **REPORTED**
03/26/90 03/26/90 04/03/90
12:15

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** POLYNUCLEAR AROMATIC-WATER				
PNA ANALYSIS DATE	3/28/90			
PNA EXTRACTION DATE	3/29/90			
DETECTION LIMIT 20X THE LIMIT INDICATED.				
ACENAPHTHENE	ND	UG/L	1.9	8270
ACENAPHTHYLENE	ND	UG/L	3.5	8270
ANTHRACENE	ND	UG/L	1.9	8270
BENZO (A) ANTHRACENE	ND	UG/L	7.8	8270
BENZO (A) PYRENE	ND	UG/L	2.5	8270
BENZO (B) FLUORANTHENE	ND	UG/L	4.8	8270
BENZO (GHI) PERYLENE	ND	UG/L	4.1	8270
BENZO (K) FLUORANTHENE	ND	UG/L	2.5	8270
CHRYSENE	ND	UG/L	2.5	8270
DIBNZO-AH-ANTHRACENE	ND	UG/L	2.5	8270
FLOURANTHENE	ND	UG/L	2.2	8270
FLUORENE	ND	UG/L	1.9	8270
INDENO-123CD-PYRENE	ND	UG/L	3.7	8270
NAPHTHALENE	240	UG/L	1.6	8270
PHENANTHRENE	ND	UG/L	5.4	8270
PYRENE	ND	UG/L	1.9	8270

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00853895

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.20 (GZ1)
60 OLYMPIA AVE
WOBURN
N. DAVIS

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED	RECEIVED	REPORTED
03/26/90 12:30	03/26/90	04/02/90

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** POLYNUCLEAR AROMATIC-WATER				
PNA ANALYSIS DATE	3/28/90			
PNA EXTRACTION DATE	3/29/90			
DETECTION LIMIT AS INDICATED.				
ACENAPHTHENE	ND	UG/L	1.9	8270
ACENAPHTHYLENE	ND	UG/L	3.5	8270
ANTHRACENE	ND	UG/L	1.9	8270
BENZO (A) ANTHRACENE	ND	UG/L	7.8	8270
BENZO (A) PYRENE	ND	UG/L	2.5	8270
BENZO (B) FLUORANTHENE	ND	UG/L	4.8	8270
BENZO (GHI) PERYLENE	ND	UG/L	4.1	8270
BENZO (K) FLUORANTHENE	ND	UG/L	2.5	8270
CHRYSENE	ND	UG/L	2.5	8270
DIBNZO-AH-ANTHRACENE	ND	UG/L	2.5	8270
FLOURANTHENE	ND	UG/L	2.2	8270
FLUORENE	ND	UG/L	1.9	8270
INDENO-123CD-PYRENE	ND	UG/L	3.7	8270
NAPHTHALENE	ND	UG/L	1.6	8270
PHENANTHRENE	ND	UG/L	5.4	8270
PYRENE	ND	UG/L	1.9	8270

*** THIS IS A FINAL REPORT. ***



WATER CONTROL LABORATORIES
A DIVISION OF COOPERATING MANAGEMENT INC.
HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00753479

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (MW1)
60 OLYMPIA, WOBURN

N. DAVIS

REFERRED BY:

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

NEWTON UPPER FALL, MA

COLLECTED	RECEIVED	REPORTED
03/15/90 00:00	03/16/90	04/02/90

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	ND		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	470		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRAN12DICHLOROETHENE	ND		UG/L	
CIS-12DICHLOROETHENE	2,760		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2TRICHLOROETHANE	ND		UG/L	
1112TETRACHLORETHANE	ND		UG/L	
1122TETRACHLROETHANE	ND		UG/L	
TETRACHLOROETHENE	520		UG/L	
123-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (MW1)



WATER CONTROL LABORATORIES
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HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #

00753479

ACCOUNT #

000504

CODE PAGE #

E01 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (MW1)
60 OLYMPIA, WOBURN

REFERRED BY:

N. DAVIS

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED 03/15/90 00:00
RECEIVED 03/16/90
REPORTED 04/02/90

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	SEE NOTE		UG/L	
P-XYLENE AND M-XYLENE = 840 UG/L.				
COELUTION PROHIBITS SEPARATION.				
O-XYLENE	1,880		UG/L	
M-XYLENE	SEE NOTE		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	1,050		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHLORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	4,370		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	5,620		UG/L	
124 TRIMETHYLBENZENE	ND		UG/L	
135 TRIMETHYLBENZENE	3,870		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	SEE NOTE	UG/L	0.0	

ND = LESS THAN THE DETECTION LIMIT INDICATED.

DETECTION LIMIT = 500 UG/L.

*** THIS IS A FINAL REPORT. ***



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HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 * Conn Cert No PH-0515 * EPA ID No MA059

WCL ID #
00753480

ACCOUNT #
000504

CODE **PAGE #**
E01 1

SAMPLE IDENTIFICATION INFORMATION

4596.2 (MW2)
60 OLYMPIA AV, WOBURN

REFERRED BY:

N. DAVIS

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED **RECEIVED** **REPORTED**
03/15/90 03/16/90 04/02/90
00:00

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** GENERAL INFORMATION				
COLLECTOR: GZA				
*** VOLATILE ORGANICS (524.2)				
BENZENE	17.8		UG/L	
CARBON TETRACHLORIDE	ND		UG/L	
1,1-DICHLOROETHENE	ND		UG/L	
1,2-DICHLOROETHANE	ND		UG/L	
PARA DICHLOROBENZENE	ND		UG/L	
TRICHLOROETHENE	16.6		UG/L	
111-TRICHLOROETHANE	ND		UG/L	
VINYL CHLORIDE	ND		UG/L	
BROMOBENZENE	ND		UG/L	
BROMODICHLOROMETHANE	ND		UG/L	
BROMOFORM	ND		UG/L	
BROMOMETHANE	ND		UG/L	
CHLOROBENZENE	ND		UG/L	
CHLORODIBROMOMETHANE	ND		UG/L	
CHLOROETHANE	ND		UG/L	
CHLOROFORM	ND		UG/L	
CHLOROMETHANE	ND		UG/L	
O-CHLOROTOLUENE	ND		UG/L	
P-CHLOROTOLUENE	ND		UG/L	
DIBROMOMETHANE	ND		UG/L	
M-DICHLOROBENZENE	ND		UG/L	
O-DICHLOROBENZENE	ND		UG/L	
TRANS-1,2-DICHLOROETHENE	ND		UG/L	
CIS-1,2-DICHLOROETHENE	621		UG/L	
DICHLOROMETHANE	ND		UG/L	
1,1-DICHLOROETHANE	ND		UG/L	
1,1-DICHLOROPROPENE	ND		UG/L	
1,3-DICHLOROPROPENE	ND		UG/L	
1,2-DICHLOROPROPANE	ND		UG/L	
2,2-DICHLOROPROPANE	ND		UG/L	
ETHYLBENZENE	ND		UG/L	
STYRENE	ND		UG/L	
1,1,2-TRICHLOROETHANE	ND		UG/L	
1,1,1,2-TETRACHLOROETHANE	ND		UG/L	
1,1,2,2-TETRACHLOROETHANE	ND		UG/L	
TETRACHLOROETHENE	ND		UG/L	
1,2,3-TRICHLOROPROPANE	ND		UG/L	

CONTINUED ON NEXT PAGE

4596.2 (MW2)



WATER CONTROL LABORATORIES
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HOPKINTON INDUSTRIAL PARK
106 SOUTH ST
HOPKINTON, MA 01748
508-435-6824
Mass Cert No 313 • Conn Cert No PH-0515 • EPA ID No MA059

WCL ID #

00753480

ACCOUNT #

000504

CODE PAGE #

E01 2

SAMPLE IDENTIFICATION INFORMATION

4596.2 (MW2)
60 OLYMPIA AV, WOBURN

REFERRED BY:

N. DAVIS

GOLDBERG, ZOINO & ASSOCIATES
320 NEEDHAM ST.

COLLECTED RECEIVED REPORTED

03/15/90 03/16/90 04/02/90
00:00

NEWTON UPPER FALL, MA

REPORT:

FINAL REPORT

COMMENT:

TESTS	RESULTS	UNITS	DETECTION LIMIT	METHOD
*** VOLATILE ORGANICS (524.2)				
TOLUENE	ND		UG/L	
P-XYLENE	ND		UG/L	
O-XYLENE	17.4		UG/L	
M-XYLENE	ND		UG/L	
BROMOCHLOROMETHANE	ND		UG/L	
N-BUTYLBENZENE	ND		UG/L	
DICHLORDIFLOURO-CH4	ND		UG/L	
FLUOROTRICHORO-CH4	ND		UG/L	
HEXACHLOROBUTADIENE	ND		UG/L	
ISOPROPYLBENZENE	ND		UG/L	
P-ISOPROPYLTOLUENE	ND		UG/L	
NAPTHALENE	37.2		UG/L	
N-PROPYLBENZENE	ND		UG/L	
SEC-BUTLYBENZENE	ND		UG/L	
TERT-BUTYLBENZENE	ND		UG/L	
123 TRICHLOROBENZENE	ND		UG/L	
124 TRICHLOROBENZENE	ND		UG/L	
124 TRIMETHYLBENZENE	61.8		UG/L	
135 TRIMETHYLBENZENE	40.2		UG/L	
1,3-DICHLOROPROPANE	ND		UG/L	
DETECTION LIMIT	SEE NOTE	UG/L	0.0	

ND = LESS THAN THE DETECTION LIMIT INDICATED.

DETECTION LIMIT = 10 UG/L.

*** THIS IS A FINAL REPORT. ***



January 30, 1990

Mr. Ted Pickering.
Goldberg-Zoino & Associates, Inc.
320 Needham Street
Newton Upper Falls, MA 02164

Dear Mr. Pickering:

Enclosed are the results of the analyses performed on the eight aqueous samples for 60 Olympia Ave. Woburn Phase II (Project No. 2-4596.2; Purchase Order No. 1-6602). This project was received under chain of custody at Enseco - Erco Laboratory on January 12, 1990, and was processed for a three-week turnaround time. A brief description of the Quality Assurance/Quality Control and methods employed by Enseco are contained within the report. This letter authorizes the release of the analytical results and should be considered an integral part of this report.

Please refer to this project by the Erco Laboratory Identification No. 5391 to help expedite any future discussions. We will be happy to answer any questions or concerns that you may have.

Sincerely,

Alice R. Lee
Program Administrator

Encl.

SAMPLE DESCRIPTION INFORMATION
for
Goldberg-Zoino & Associates, Inc.

Lab ID	Client ID	Matrix	Sampled Date Time	Received Date
005391-0001-SA	GZ-1	AQUEOUS	09 JAN 90	12 JAN 90
005391-0002-SA	GZ-3	AQUEOUS	09 JAN 90	12 JAN 90
005391-0003-SA	GZ-3D	AQUEOUS	09 JAN 90	12 JAN 90
005391-0004-SA	GZ-4	AQUEOUS	09 JAN 90	12 JAN 90
005391-0005-SA	GZ-11	AQUEOUS	09 JAN 90	12 JAN 90
005391-0006-SA	GZ-12	AQUEOUS	09 JAN 90	12 JAN 90
005391-0007-SA	GZ-5	AQUEOUS	09 JAN 90	12 JAN 90
005391-0008-SA	B-3A	AQUEOUS	09 JAN 90	12 JAN 90

- ANALYTICAL RESULTS -

ANALYTICAL RESULTS

The method number provided on each data report sheet refers to a publication originating from a regulatory or standard-setting organization. In general, the methods employed are those specified by the U.S. Environmental Protection Agency and other state and federal agencies. In cases where an approved regulatory method does not exist, a method developed by Enseco will be employed to meet the specific needs of the client. The methods commonly employed by Enseco are based on methods from the following references.

U.S. Environmental Protection Agency. 1983. Methods for chemical analysis of water and wastes. EPA-600/4-79-020. Cincinnati, OH, March.

U.S. Environmental Protection Agency. 1984. Test methods for evaluating solid waste, physical/chemical methods. (SW-846); Washington, D.C. April.

U.S. Environmental Protection Agency. 1986. Methods for determination of organic compounds in finished drinking water and raw source water. Cincinnati, OH, March.

"Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," 40 CFR, Part 136; Federal Register, Vol. 49, No. 209.

American Public Health Association, American Water Works Association, Water Pollution Control Federation. 1985. Standard methods for the examination of water and wastewater, 16th edition. Washington, D.C., April.

Current EPA Contract Laboratory Program (CLP) protocols for the analysis of organic and inorganic hazardous substances including chlorinated dioxins and furans.

- QUALITY ASSURANCE/QUALITY CONTROL -

QUALITY ASSURANCE/QUALITY CONTROL

As an indication of the overall quality of the data generated by Enseco - Erco Laboratory for this report, the following controls have been provided (when applicable).

Method blanks are analyzed to assess the level of contamination which exists in the analytical system. A method blank, analyzed with every batch of samples, consists of reagents specific to the method. This blank is carried through every aspect of the procedure, including preparation, cleanup, and analysis. Ideally, the concentration of an analyte in the blank is below the reporting limit for that analyte. However, some common laboratory solvents and metals are difficult to eliminate to the part-per-billion levels commonly reported in environmental analyses. Therefore, all method blank data is reported to the client. Data are not blank-corrected.

Duplicate control samples (DCS) are used to monitor the laboratory's day-to-day performance of routine analytical methods. A DCS consists of a standard, control matrix which is spiked with a group of target compounds representative of the method analytes. The DCS is analyzed with environmental samples to provide evidence that the laboratory is performing the method within accepted QC guidelines.

A DCS has been established for most routine analytical methods. Reagent water is used as the control matrix for the analysis of aqueous samples. The DCS compounds are spiked into reagent water and carried through the appropriate steps of the analysis. As stated in SW-846 (third edition), a universal blank matrix does not exist for solid samples and therefore no matrix is used. The DCS for solid samples consists of the DCS compounds spiked into a reagent blank and carried through the appropriate steps of the analysis. The data thus obtained are used to set the DCS control limits. As sufficient laboratory data become available, the control limits are redefined based upon the most recent six months of DCS data. Control limits for accuracy are based on the historical average recovery of the DCS plus or minus three standard deviation units, or alternatively on established control limits defined in the methodology.

Surrogates are organic compounds that are similar to the analytes of interest in chemical behavior but which are not normally found in environmental samples. Enseco routinely adds surrogates to samples requiring GC/MS and most GC analysis and reports these surrogate recoveries to the client. These surrogates are added to samples to monitor the effect of the matrix on the accuracy of the analysis. Results are reported in terms of percent recovery.

QC LOT ASSIGNMENT REPORT
Hydrocarbon

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
005391-0001-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1
005391-0002-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1
005391-0003-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1
005391-0004-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1
005391-0005-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1
005391-0006-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1
005391-0007-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1
005391-0008-SA	AQUEOUS	TPH-IR-A	17 JAN 90-FA	17 JAN 90-F1

DUPLICATE CONTROL SAMPLE REPORT
Hydrocarbon

Analyte	Spiked	Concentration		AVG	Accuracy		Precision	
		DCS1	Measured DCS2		Average(%) DCS	Limits	(RPD) DCS Limit	Limit
Category: TPH-IR-A Matrix: AQUEOUS QC Lot: 17 JAN 90-FA Concentration Units: mg/L								
Fuel Oil #2	10	10.1	8.70	9.40	94	60-140	15	30

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Hydrocarbon

Analyte	Result	Units	Reporting Limit
---------	--------	-------	-----------------

Test: TPH-IR-A
Matrix: AQUEOUS
QC Lot: 17 JAN 90-FA QC Run: 17 JAN 90-F1

Total Petroleum Hydrocarbons	ND	mg/L	2.0
------------------------------	----	------	-----

Test: TPH-IR-A
Matrix: AQUEOUS
QC Lot: 17 JAN 90-FA QC Run: 17 JAN 90-F1

Total Petroleum Hydrocarbons	ND	mg/L	2.0
------------------------------	----	------	-----

HYDROCARBON FINGERPRINTING

Enseco
CORPORATION

Modified ASTM Method D3328

Quality Control

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: Laboratory Control Spike Duplicate

Lab ID: 28 DEC 89-FAD

Matrix: Aqueous

Authorized: NA

Sampled: NA

Prepared: 28 DEC 89

Received: NA

Analyzed: 12 JAN 90

Parameter	Percent Recovery	QC Advisory Limits
ortho-Terphenyl	87	60-120%
Fuel Oil No. 2	117	60-120%

N.A. = Not Applicable

Reported by: Andrew Cram

Approved By: Robert Lizotte

HYDROCARBON FINGERPRINTING

Modified ASTM Method D3328

Quality Control

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: Laboratory Control Spike

Lab ID: 28 DEC 89-FA

Matrix: Aqueous

Authorized: NA

Sampled: NA

Prepared: 28 DEC 89

Received: NA

Analyzed: 12 JAN 90

Parameter	Percent Recovery	QC Advisory Limits
ortho-Terphenyl	114	60-120%
Fuel Oil No. 2	100	60-120%

N.A. = Not Applicable

Reported by: Andrew Cram

Approved By: Robert Lizotte

HYDROCARBON FINGERPRINTING

Enseco
ANALYTICAL

Modified ASTM Method D3328

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: B-3A

Lab ID: 5391-08

Matrix: Aqueous

Authorized: 12 JAN 90

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 27 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbon	0.04	mg/L (ppm)	See below
Individual Hydrocarbon	NA	mg/L (ppm)	0.01
Total Product	NA	mg/L (ppm)	0.50
o-Terphenyl	NA	%	NA

Qualitative Identification: NA

Minimum reporting limit for individual hydrocarbons = 0.01 mg/L (ppm).
Minimum reporting limit for total products = 0.50 mg/L (ppm).

N.D. = Not Detected
N.A. = Not Applicable

Reported by: Andrew Cram

Approved By: Robert Lizotte

PETROLEUM HYDROCARBON ANALYSIS BY IR

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: B-3A

Lab ID: 005391-0008-SA

Matrix: AQUEOUS

Authorized: 15 JAN 90

Enseco ID: 2035573

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	ND	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

PETROLEUM HYDROCARBON ANALYSIS BY IR

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ-12

Lab ID: 005391-0006-SA

Matrix: AQUEOUS

Authorized: 15 JAN 90

Enseco ID: 2035571

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	ND	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

PETROLEUM HYDROCARBON ANALYSIS BY IR

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ-11

Lab ID: 005391-0005-SA

Matrix: AQUEOUS

Authorized: 15 JAN 90

Enseco ID: 2035570

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	ND	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

HYDROCARBON FINGERPRINTING

Enseco
CORPORATION

Modified ASTM Method D3328

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ5

Lab ID: 5391-07

Matrix: Aqueous

Authorized: 12 JAN 90

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 27 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbon	0.26	mg/L (ppm)	See below
Individual Hydrocarbon	NA	mg/L (ppm)	0.01
Total Product	NA	mg/L (ppm)	0.50
o-Terphenyl	NA	%	NA

Qualitative Identification: NA

Minimum reporting limit for individual hydrocarbons = 0.01 mg/L (ppm).
Minimum reporting limit for total products = 0.50 mg/L (ppm).

N.D. = Not Detected
N.A. = Not Applicable

Reported by: Andrew Cram

Approved By: Robert Lizotte

PETROLEUM HYDROCARBON ANALYSIS BY IR

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ-5

Lab ID: 005391-0007-SA

Matrix: AQUEOUS

Authorized: 15 JAN 90

Enseco ID: 2035572

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	2.0	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

PETROLEUM HYDROCARBON ANALYSIS BY IR

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ-1

Lab ID: 005391-0001-SA

Enseco ID: 2035566

Matrix: AQUEOUS

Sampled: 09 JAN 90

Received: 12 JAN 90

Authorized: 15 JAN 90

Prepared: 17 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	ND	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

PETROLEUM HYDROCARBON ANALYSIS BY IR

Enseco
CORPORATION

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ-3

Lab ID: 005391-0002-SA

Enseco ID: 2035567

Matrix: AQUEOUS

Sampled: 09 JAN 90

Received: 12 JAN 90

Authorized: 15 JAN 90

Prepared: 17 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	ND	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

PETROLEUM HYDROCARBON ANALYSIS BY IR

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ-3D

Lab ID: 005391-0003-SA

Matrix: AQUEOUS

Authorized: 15 JAN 90

Enseco ID: 2035568

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	ND	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

PETROLEUM HYDROCARBON ANALYSIS BY IR

Method 418.1

Client Name: Goldberg-Zoino & Associates, Inc.

Client ID: GZ-4

Lab ID: 005391-0004-SA

Matrix: AQUEOUS

Authorized: 15 JAN 90

Enseco ID: 2035569

Sampled: 09 JAN 90

Prepared: 17 JAN 90

Received: 12 JAN 90

Analyzed: 18 JAN 90

Parameter	Result	Units	Reporting Limit
Total Petroleum Hydrocarbons	ND	mg/L	2.0

ND = Not detected
NA = Not applicable

Reported By: Bill Clayton

Approved By: Andrew Cram

5390

[illegible]

APPENDIX J

**GZA ANALYTICAL METHODS AND RESULTS
FOR WATER SAMPLES**

GOLDBERG-ZOINO & ASSOCIATES, ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164 (617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

EPA METHOD 8240 ANALYSIS FOR VOLATILE ORGANICS BY GC/MS

JOB DESCRIPTION: OLYMPIA AVE. - JUNIPER DEVELOPMENT GROUP

JOB #: 4596.2

SAMPLE #: SS-1

MATRIX: AQUEOUS

LABORATORY #: A4968

DATE SAMPLED: 9/12/90

DATE TESTED: 9/17/90

DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST	CONCENTRATION	QUANTITATION LIMIT
8240 COMPOUNDS:	ug/l or ug/kg (PPB)	ug/l or ug/kg (PPB)
CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
METHYLENE CHLORIDE	ND	10
1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5
1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS 1,3-DICHLOROPROPENE	ND	5
TRICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS 1,3-DICHLOROPROPENE	ND	5
BROMOFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHENE	ND	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5
ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	10
1,3-DICHLOROBENZENE	ND	10
1,4-DICHLOROBENZENE	ND	10

SEE PAGE 2 - FOR REMAINING COMPOUNDS

EPA METHOD 8240 ANALYSIS
FOR VOLATILE ORGANICS BY GC/MS

JOB DESCRIPTION: OLYMPIA AVE. - JUNIPER DEVELOPMENT GROUP
JOB #: 4596.2
SAMPLE #: SS-1
MATRIX: AQUEOUS
LABORATORY #: A4968

HAZARDOUS SUBSTANCE LIST 8240 COMPOUNDS	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
ACETONE	ND	50
CARBON DISULFIDE	ND	5
2-BUTANONE (MEK)	ND	100
VINYL ACETATE	ND	20
2-HEXANONE (MBK)	ND	20
4-METHYL-2-PENTANONE (MIBK)	ND	20
TOTAL XYLENES	ND	5
STYRENE	ND	5

MISCELLANEOUS 8240 COMPOUNDS:	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
METHYL-t-BUTYL ETHER	ND	10
TRICHLOROFLUOROMETHANE	ND	20

SURROGATES	% RECOVERY
1,2-DICHLOROETHANE - D4	97.5
TOLUENE - D8	100
4-BROMOFLUOROBENZENE	97.8

COMMENTS:

ANALYZED BY: ALL · A. Katschky

REVIEWED BY: KW *W. W. W.*

GOLDBERG-ZOINO & ASSOCIATES, ENVIRONMENTAL CHEMISTRY LABORATORY
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MASSACHUSETTS LABORATORY I.D. NO. MA092

EPA METHOD 8240 ANALYSIS FOR VOLATILE ORGANICS BY GC/MS

JOB DESCRIPTION: OLYMPIA AVE. - JUNIPER DEVELOPMENT GROUP

JOB #: 4596.2

SAMPLE #: SS-2

MATRIX: AQUEOUS

LABORATORY #: A4971

DATE SAMPLED: 9/12/90

DATE TESTED: 9/17/90

DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST	CONCENTRATION	QUANTITATION LIMIT
8240 COMPOUNDS:	ug/l or ug/kg (PPB)	ug/l or ug/kg (PPB)
CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
METHYLENE CHLORIDE	ND	10
1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5
1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS 1,3-DICHLOROPROPENE	ND	5
TRICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS 1,3-DICHLOROPROPENE	ND	5
BROMOFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHENE	ND	5
TOLUENE	--5.3--	5
CHLOROBENZENE	ND	5
ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	10
1,3-DICHLOROBENZENE	ND	10
1,4-DICHLOROBENZENE	ND	10

SEE PAGE 2 - FOR REMAINING COMPOUNDS

**EPA METHOD 8240 ANALYSIS
FOR VOLATILE ORGANICS BY GC/MS**

JOB DESCRIPTION: OLYMPIA AVE. - JUNIPER DEVELOPMENT GROUP
JOB #: 4596.2
SAMPLE #: SS-2
MATRIX: AQUEOUS
LABORATORY #: A4971

HAZARDOUS SUBSTANCE LIST 8240 COMPOUNDS	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
ACETONE	ND	50
CARBON DISULFIDE	ND	5
2-BUTANONE (MEK)	ND	100
VINYL ACETATE	ND	20
2-HEXANONE (MBK)	ND	20
4-METHYL-2-PENTANONE (MIBK)	ND	20
TOTAL XYLENES	ND	5
STYRENE	ND	5

MISCELLANEOUS 8240 COMPOUNDS:	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
METHYL-t-BUTYL ETHER	ND	10
TRICHLOROFLUOROMETHANE	ND	20

SURROGATES	% RECOVERY
1,2-DICHLOROETHANE - D4	103
TOLUENE - D8	93.9
4-BROMOFLUOROBENZENE	74.1

COMMENTS:

ANALYZED BY: ALL B. Batady

REVIEWED BY: KW K Walsh

GOLDBERG-ZOINO & ASSOCIATES, ENVIRONMENTAL CHEMISTRY LABORATORY
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EPA METHOD 8240 ANALYSIS FOR VOLATILE ORGANICS BY GC/MS

JOB DESCRIPTION: OLYMPIA AVE. - JUNIPER DEVELOPMENT GROUP

JOB #: 4596.2

SAMPLE #: RS-1

MATRIX: AQUEOUS

LABORATORY #: A4972

DATE SAMPLED: 9/12/90

DATE TESTED: 9/17/90

DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST 8240 COMPOUNDS:	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
METHYLENE CHLORIDE	ND	10
1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5
1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS 1,3-DICHLOROPROPENE	ND	5
TRICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS 1,3-DICHLOROPROPENE	ND	5
BROMOFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHENE	ND	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5
ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	10
1,3-DICHLOROBENZENE	ND	10
1,4-DICHLOROBENZENE	ND	10

SEE PAGE 2 - FOR REMAINING COMPOUNDS

GOLDBERG-ZOINO & ASSOCIATES, ENVIRONMENTAL CHEMISTRY LABORATORY
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EPA METHOD 8240 ANALYSIS FOR VOLATILE ORGANICS BY GC/MS

JOB DESCRIPTION: OLYMPIA AVE. - JUNIPER DEVELOPMENT GROUP

JOB #: 4596.2

SAMPLE #: RS-2

MATRIX: AQUEOUS

LABORATORY #: A4973

DATE SAMPLED: 9/12/90

DATE TESTED: 9/17/90

DILUTION FACTOR: 1

PRIORITY POLLUTANT LIST 8240 COMPOUNDS:	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
CHLOROMETHANE	ND	10
BROMOMETHANE	ND	10
VINYL CHLORIDE	ND	10
CHLOROETHANE	ND	10
METHYLENE CHLORIDE	ND	10
1,1-DICHLOROETHENE	ND	5
1,1-DICHLOROETHANE	ND	5
TOTAL 1,2-DICHLOROETHENES	ND	5
CHLOROFORM	ND	5
1,2-DICHLOROETHANE	ND	5
1,1,1-TRICHLOROETHANE	ND	5
CARBON TETRACHLORIDE	ND	5
BROMODICHLOROMETHANE	ND	5
1,2-DICHLOROPROPANE	ND	5
TRANS 1,3-DICHLOROPROPENE	ND	5
TRICHLOROETHENE	ND	5
DIBROMOCHLOROMETHANE	ND	5
1,1,2-TRICHLOROETHANE	ND	5
BENZENE	ND	5
CIS 1,3-DICHLOROPROPENE	ND	5
BROMOFORM	ND	5
1,1,2,2-TETRACHLOROETHANE	ND	5
TETRACHLOROETHENE	ND	5
TOLUENE	ND	5
CHLOROBENZENE	ND	5
ETHYL BENZENE	ND	5
1,2-DICHLOROBENZENE	ND	10
1,3-DICHLOROBENZENE	ND	10
1,4-DICHLOROBENZENE	ND	10

SEE PAGE 2 - FOR REMAINING COMPOUNDS

EPA METHOD 8240 ANALYSIS
FOR VOLATILE ORGANICS BY GC/MS

JOB DESCRIPTION: OLYMPIA AVE. - JUNIPER DEVELOPMENT GROUP
 JOB #: 4596.2
 SAMPLE #: RS-2
 MATRIX: AQUEOUS
 LABORATORY #: A4973

HAZARDOUS SUBSTANCE LIST 8240 COMPOUNDS	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
ACETONE	--430--	50
CARBON DISULFIDE	ND	5
2-BUTANONE (MEK)	ND	100
VINYL ACETATE	ND	20
2-HEXANONE (MBK)	ND	20
4-METHYL-2-PENTANONE (MIBK)	ND	20
TOTAL XYLENES	ND	5
STYRENE	ND	5

MISCELLANEOUS 8240 COMPOUNDS:	CONCENTRATION ug/l or ug/kg (PPB)	QUANTITATION LIMIT ug/l or ug/kg (PPB)
METHYL-t-BUTYL ETHER	--100--	10
TRICHLOROFLUOROMETHANE	ND	20

SURROGATES	% RECOVERY
1,2-DICHLOROETHANE - D4	92.4
TOLUENE - D8	100
4-BROMOFLUOROBENZENE	92.3

COMMENTS:

ANALYZED BY: ALL *B. Katady*

REVIEWED BY: KW *KW*

EPA METHOD 8240 ANALYSIS FOR VOLATILE ORGANICS BY GC/MS

OVERVIEW

EPA Method 8240 is a purge and trap gas chromatographic method for the identification and quantification of volatile organic compounds in aqueous and solid samples. Purge and trap is a dynamic headspace technique where volatiles in an aqueous/solid sample are completely stripped from the aqueous/solid phase to vapor phase. The volatiles from the depleted sample are collected on an absorbent trap, thermally desorbed to a gas chromatograph for separation, and routed to a mass spectrometer.

METHODOLOGY

A Tekmar Model LSC-2000 Liquid Sample Concentrator is used in conjunction with a Tekmar Model ALS2016 Automatic Laboratory Sampler to purge volatile compounds by bubbling helium gas through a 5 ml aqueous matrix and passing the vapor through a tenax/silica gel sorbent trap. Aqueous samples are introduced directly into the sample sparging apparatus. Solid samples are prepared using two methods: a high level and a low level method. The high level method is a solvent extraction of the sample using capillary grade methanol of which an aliquot is spiked into reagent water and subsequently treated as an aqueous sample. The low level method involves the transfer of a five gram solid subsample to the sparging device, the addition of reagent water to the sample, and utilizing a sample heater to purge volatile components. The purgeable compounds retained on the tenax/silica gel trap are then thermally desorbed and passed through a heated line into the gas chromatograph. GZA performs this method on a Hewlett-Packard UP 5890A Gas Chromatograph and a Hewlett Packard Model 5970B Mass Selective Detector which is interfaced to a Hewlett-Packard HP 1000 RTE A Series Micro 24 System with Aquarius data acquisition software. The information for the report is entered manually onto a Lotus Symphony spreadsheet. Calibration and quality control are performed in accordance with the protocols established by the EPA and Massachusetts DEP published in the references cited below.

REPORT FORMAT

The quantitation limit is stated for every report and is adjusted when dilutions are made to bring sample response data within the calibrated range of the method. Concentrations less than the quantitation limit may be identified as Beneath Method Quantitation Limit (BMQL).

DISCLAIMER

Identities and concentrations of purgeable organic compounds by this dynamic headspace technique are subject to limitations inherent to these methods.

LABORATORY CONTACT PERSON:

Edward W. Pickering, Manager
Environmental Chemistry Laboratory
Goldberg-Zoino & Associates, Inc.
Massachusetts Laboratory I.D. No. MA 092
Phone #: (617) 969-0050 x169

REFERENCES

Commonwealth of Massachusetts DEP, "Minimum Standards for Analytical Data for Remedial Response Actions Under M.G.L.c. 21E", Policy #WSC-89-004 (1990).

McNally, M.E. and R.L. Grob, "A Review: Current Applications of Static and Dynamic Headspace Analysis: Part One: Environmental Applications", Am. Lab. 20 (1) 20-33, (1985).

U.S. EPA, "Handbook for Analytical Quality Control in Water and Waste Water Laboratories", EP-600/4-79-1019 (1979).

U.S. EPA "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", Appendix A. 40CFR Part 136, Federal Register, Vol. 49, No. 209. Method 624-Purgeables (1984).

U.S. EPA, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, Third Edition, Volume 1B, Update Method 8240: GC/MS for Volatile Organics, Method 5030: Purge and Trap. May 1989.

GOLDBERG-ZOINO & ASSOCIATES
320 NEEDHAM STREET
NEWTON UPPER FALLS, MA 02164
(617) 969-0050

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g)

↑

JOB #: 4596.2
SITE NAME: 60 OLYMPIA AVENUE
DATE SAMPLED: 3/15/90
DATE TESTED: 3/16/90

SAMPLE NAME:	METHOD BLANK	MW-1
GZA LAB #:	031690-QC	00182-FP
1. HYDROCARBON CONTENT	<1	1,900
2. PERCENT SOLID CONTENT	N/A	N/A
3. MATRIX	N/A	AQUEOUS
4. DETECTION LIMIT (TOTAL PRODUCT)	1	1
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.05	0.05
6. SURROGATE RECOVERY (O-TERPHENYL)	87%	DILUTED OUT

QUALITATIVE IDENTIFICATION:

The characteristics of the chromatogram for sample "MW-1" indicates the presence of fuel oil #2. The phytane/n-C18 ratio of 0.99 indicates that some weathering has occurred.

ANALYZED BY: KW *EW*

REVIEWED BY: EWP *EW*

**GZA HYDROCARBON FINGERPRINTING TECHNIQUE
BY GAS CHROMATOGRAPHY-FLAME IONIZATION DETECTION
(PHC FINGERPRINT, GC-FID)**

OVERVIEW

The methodology employed by GZA to determine hydrocarbon content in solid and aqueous environmental samples is a modification of ASTM Method D3328-78 in conjunction with a method developed by the U.S. Coast Guard. Data obtained by this method include an accurate total concentration of hydrocarbon content and an identification based on comparisons with laboratory petroleum standards. Identifications may also be made utilizing a virgin petroleum product acquired from a suspected source at the site.

METHODOLOGY

Solid samples are extracted using a 30 gram subsample which is initially mixed with anhydrous sodium sulfate (Na_2SO_4) to remove water from the matrix. The sample is subsequently mixed with pentane to form a slurry which is then extracted via sonic disruption. This process is repeated three times and the collected extract is cleaned up using a silica gel solid phase extraction (SPE) column. The collected elutriate is automatically concentrated to a 1 milliliter volume with a Zymark Turbovap Evaporator to enhance detection limits of the method. Aqueous samples are extracted using a 200ml aliquot in a liquid/liquid extraction device using the solvent pentane. The extraction is repeated three times and the resulting extract is prepared following the same method as with solid environmental samples.

INSTRUMENTATION

The prepared extract is analyzed for hydrocarbon content using a Hewlett Packard Model 5890A Gas Chromatograph equipped with twin flame ionization detectors and a dual column capillary inlet system. The two Megabore capillary columns chosen for the analysis are a 30meter DB-5 and a 30meter DB-1. The sixty-five minute analysis is electronically controlled by a HP 7673A Autosampler and data are acquired with a Nelson Analytical 760 Series Intelligent Interface. The chromatographic data is then transmitted to an IBM AT personal computer and analyzed using the Nelson Analytical 2600 Series Chromatographic Software. The information for the analytical report is entered manually onto a Lotus Symphony Spreadsheet. The automation of the system allows the analyst to set optimum sample arrangement including calibration standards, method blanks, and duplicates.

QUALITY CONTROL

The gas chromatograph is calibrated using an average response factor determined for hydrocarbons that is calculated from internal and surrogate standards. The calibration is checked with every batch of samples by analyzing petroleum hydrocarbons of known concentration. Identification of petroleum product type is made by comparison with

laboratory standards or with suspect petroleum sources on an individual site basis. Tracer compounds such as the isomer pair phytane/n-octadecane are routinely used to determine the degree of product "weathering" as in the case of fuel oil number 2. The surrogate standard o-terphenyl is added to samples and method blanks to determine the extraction efficiency of the applied method as a surrogate recovery.

REPORT FORMAT

The method detection limit for total hydrocarbon content has been determined empirically and is modified for each sample as a function of the dilution factor. The total concentration is summarized in the row labeled "Hydrocarbon Content". All reported results for hydrocarbon analysis environmental samples are reported in ug/g (ppm) unless otherwise indicated. Detection limits for individual hydrocarbons are reported for the purpose of determining levels of priority pollutant constituents of petroleum such as polycyclic aromatic hydrocarbons (PAH's). Surrogate recoveries are reported for all method blanks and samples.

DISCLAIMER

Identities and concentrations of petroleum hydrocarbons reported in this analytical method are subject to the limitations inherent in the cited methods. This method is not an approved EPA method but is currently undergoing a review by the ASTM Committee D-29 on water for upgrades and certification.

LABORATORY CONTACT PERSON

Edward W. Pickering
Environmental Chemistry Laboratory Manager
Telephone#: (617) 969-0050, x 169

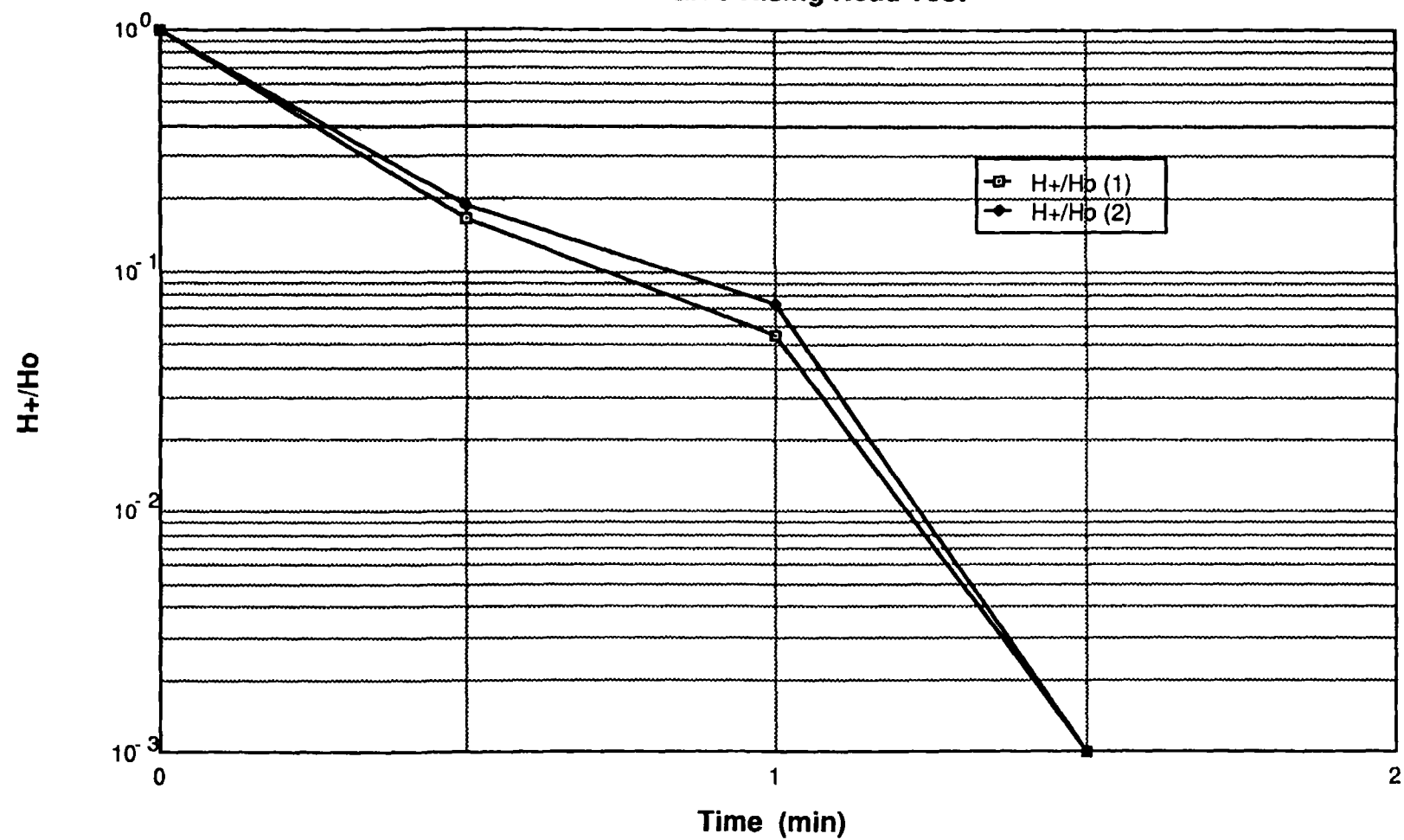
REFERENCES

- ASTM, "Standard Methods for Comparison of Waterborne Petroleum Oils by Gas Chromatography," Designation D3328, 1982.
- U.S. Coast Guard, "Oil Spill Identification System by Gas Chromatography," Report No.: CG-D-52-77, June, 1977 (pending update).

APPENDIX K

**GZA HYDRAULIC CONDUCTIVITY TESTING METHODS,
RESULTS AND CALCULATIONS**

GZ-9 Rising Head Test



4596.2.gz9

Thu, May 10, 1990 11:46 AM

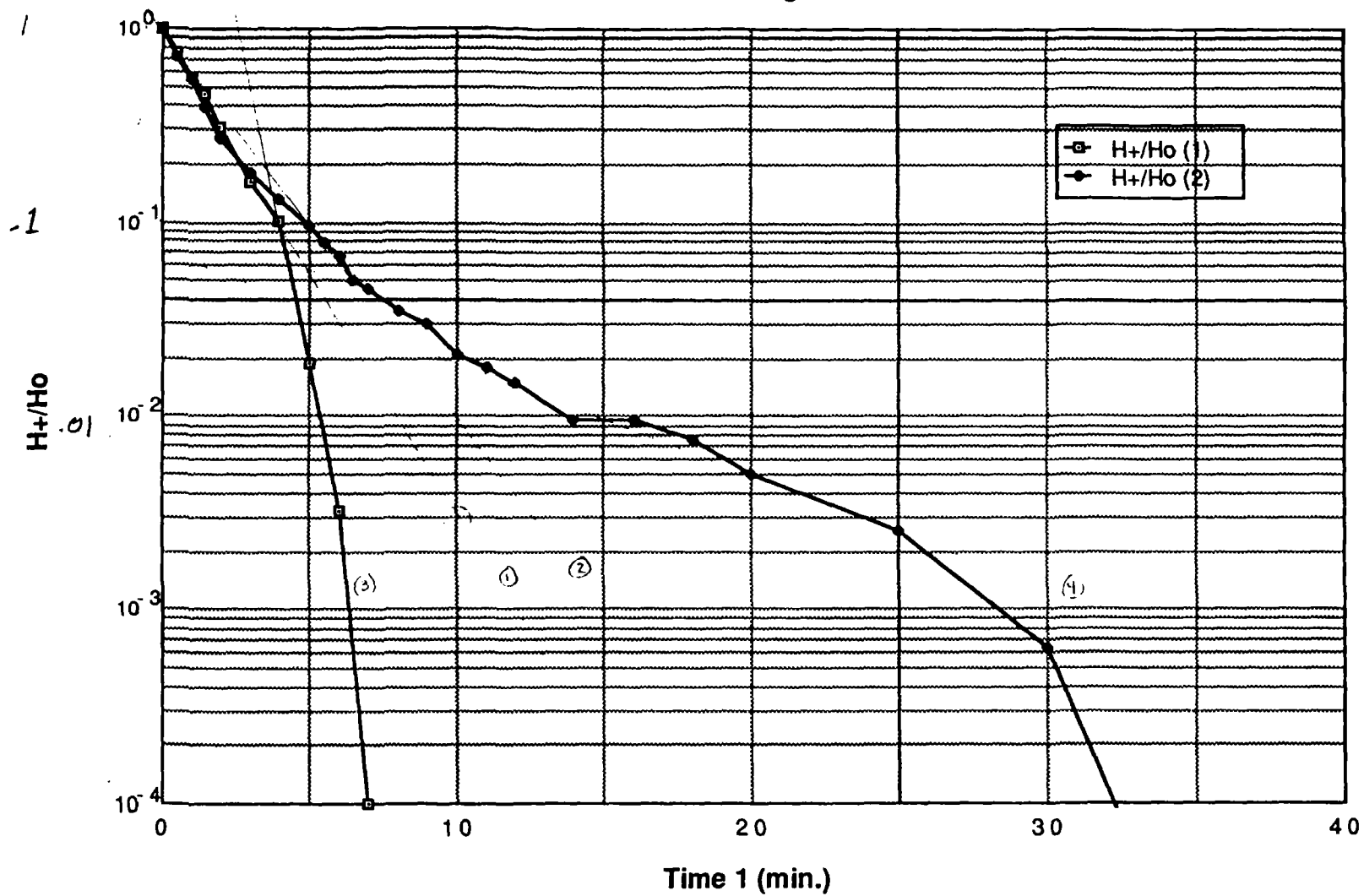
	Time 1 (min)	Depth 1 (ft.)	Draw 1 (ft.)	H+/Ho (1)	Depth 2 (ft.)	Draw 2 (ft.)	H+/Ho (2)
1	0	9.42	4.090	1.000	9.66	4.340	1.000
2	.5	6.01	0.680	0.166	6.13	0.810	0.187
3	1	5.55	0.220	0.054	5.64	0.320	0.074
4	1.5	5.33	0.000	0.001	5.32	0.000	0.001

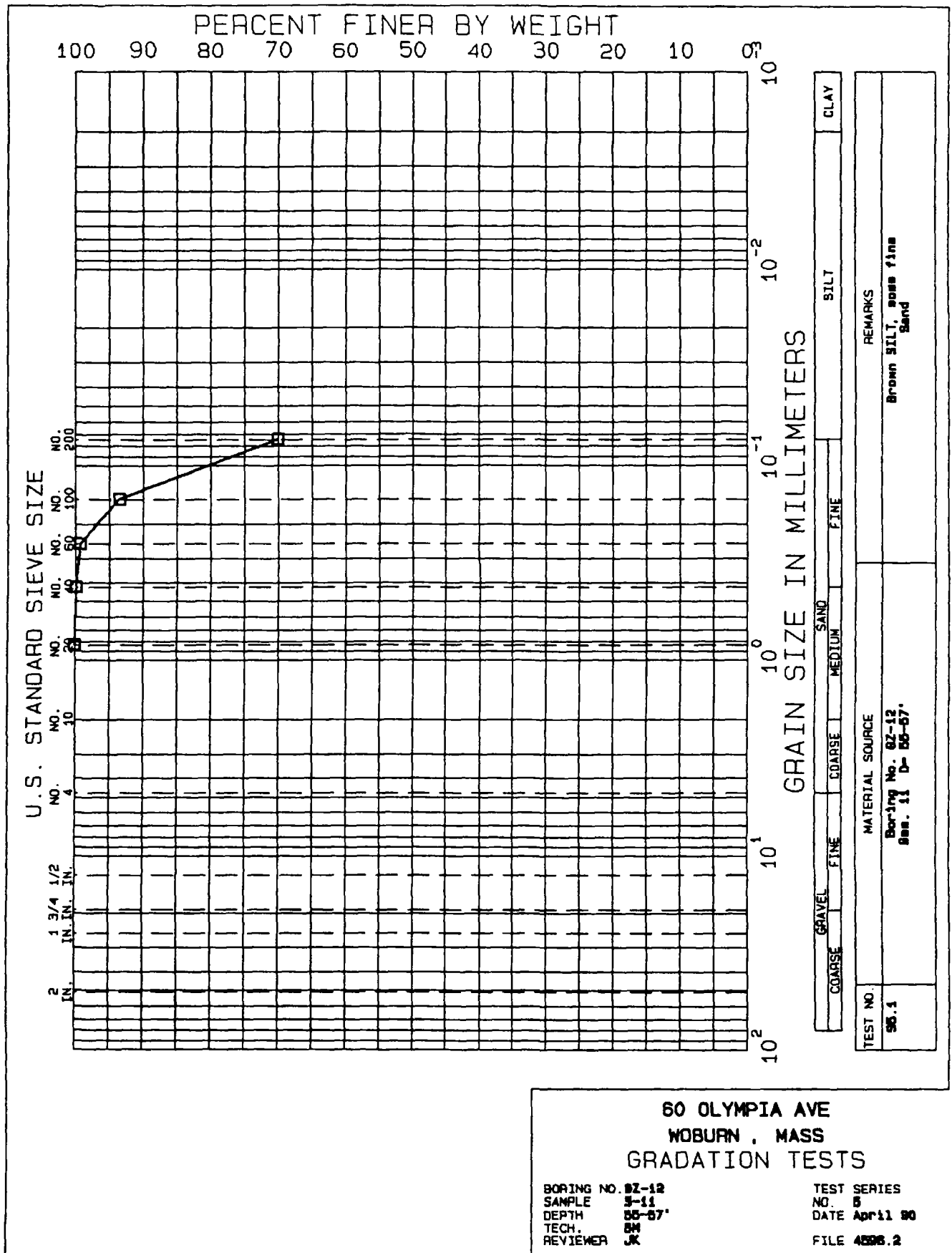
4596.2.gz11

Thu, May 10, 1990 11:19 AM

	Time 1 (min.)	Depth 1 (ft.)	H+/Ho (1)	Time 2 (min.)	Depth 2 (ft.)	H+/Ho (2)	draw (1)	draw (2)
1	0	20.8	1.000	0	21.15	1.000	15.580	15.750
2	.5	16.88	0.748 -	.5	16.53	0.707	11.660 -	11.130
3	1	13.98	0.562 -	1	14.14	0.555	8.760 -	8.740
4	1.5	12.32	0.456	1.5	11.52	0.389	7.100	6.120
5	2	10.11	0.314	2	9.67	0.271	4.890	4.270
6	3	7.78	0.164	3	8.27	0.182	2.560	2.870
7	4	6.81	0.102	4	7.47	0.131	1.590	2.070
8	5	5.51	0.019	5	6.92	0.097	0.290	1.520
9	6	5.27	3.209e-3	5.5	6.63	0.078	0.050	1.230
10	7	5.22	0.0001	6	6.45	0.067	0.000	1.050
11				6.5	6.21	0.051		0.810
12				7	6.12	0.046		0.720
13				8	5.95	0.035		0.550
14				9	5.88	0.030		0.480
15				10	5.73	0.021		0.330
16				11	5.68	0.018		0.280
17				12	5.64	0.015		0.240
18				14	5.55	9.524e-3		0.150
19				16	5.55	9.524e-3		0.150
20				18	5.52	7.619e-3		0.120
21				20	5.48	5.079e-3		0.080
22				25	5.44	2.540e-3		0.040
23				30	5.41	6.349e-4		0.010
24				35	5.40	0.00001		0.000

GZ-11 Rising Head Tests

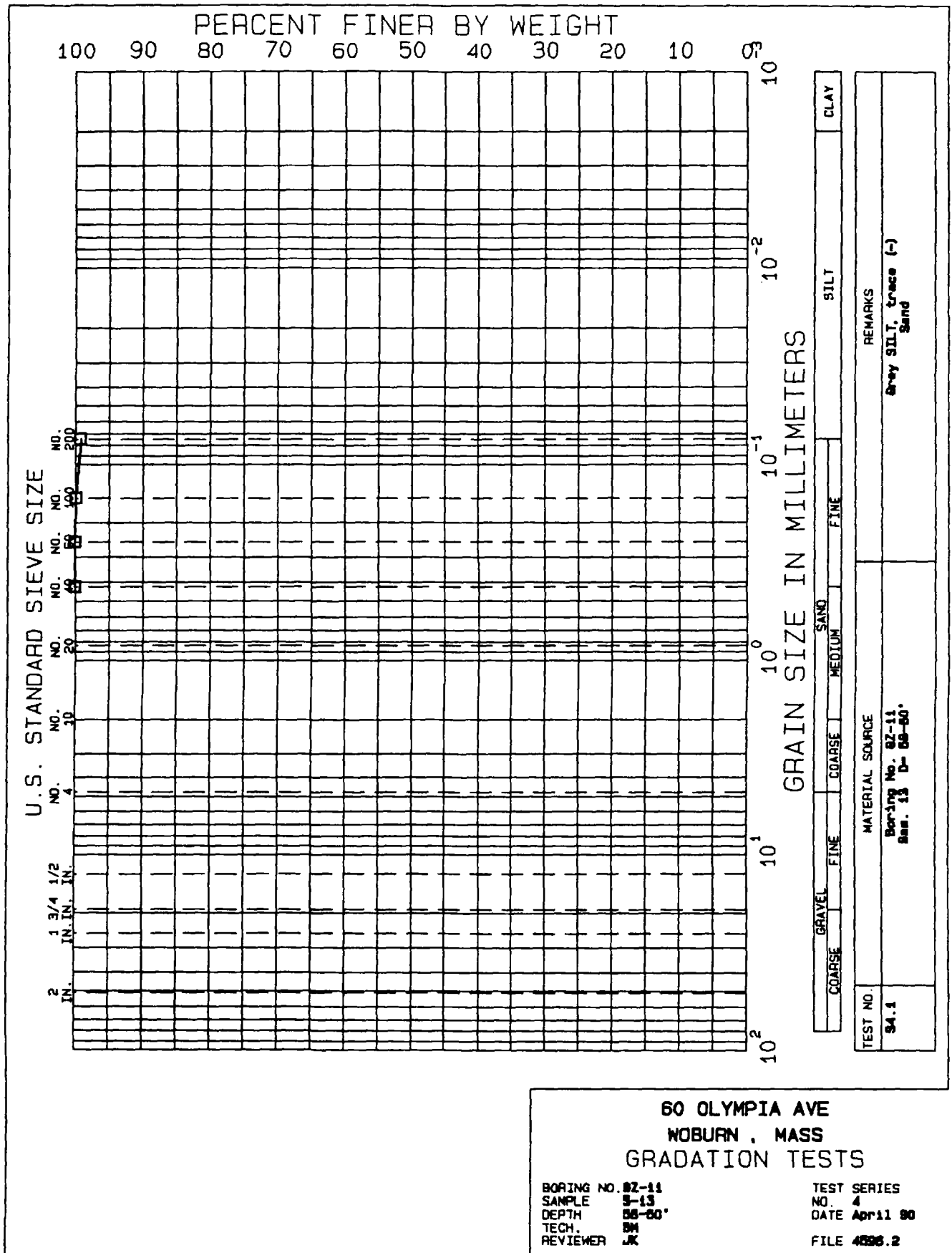


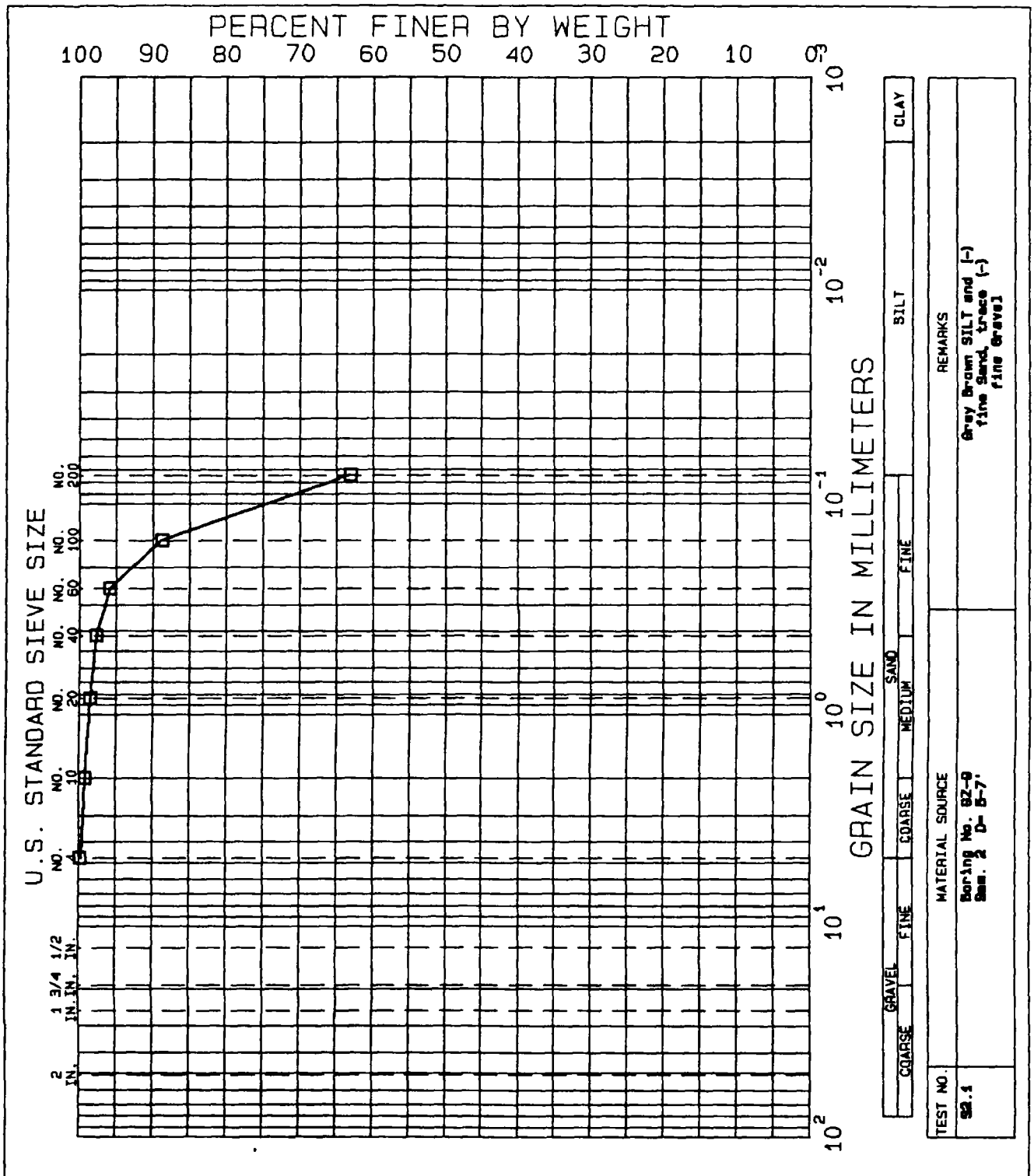


60 OLYMPIA AVE
WOBURN, MASS
GRADATION TESTS

BORING NO. 82-12
 SAMPLE 5-11
 DEPTH 88-87'
 TECH. BM
 REVIEWER JK

TEST SERIES
 NO. 8
 DATE April 11 80
 FILE 4598.2

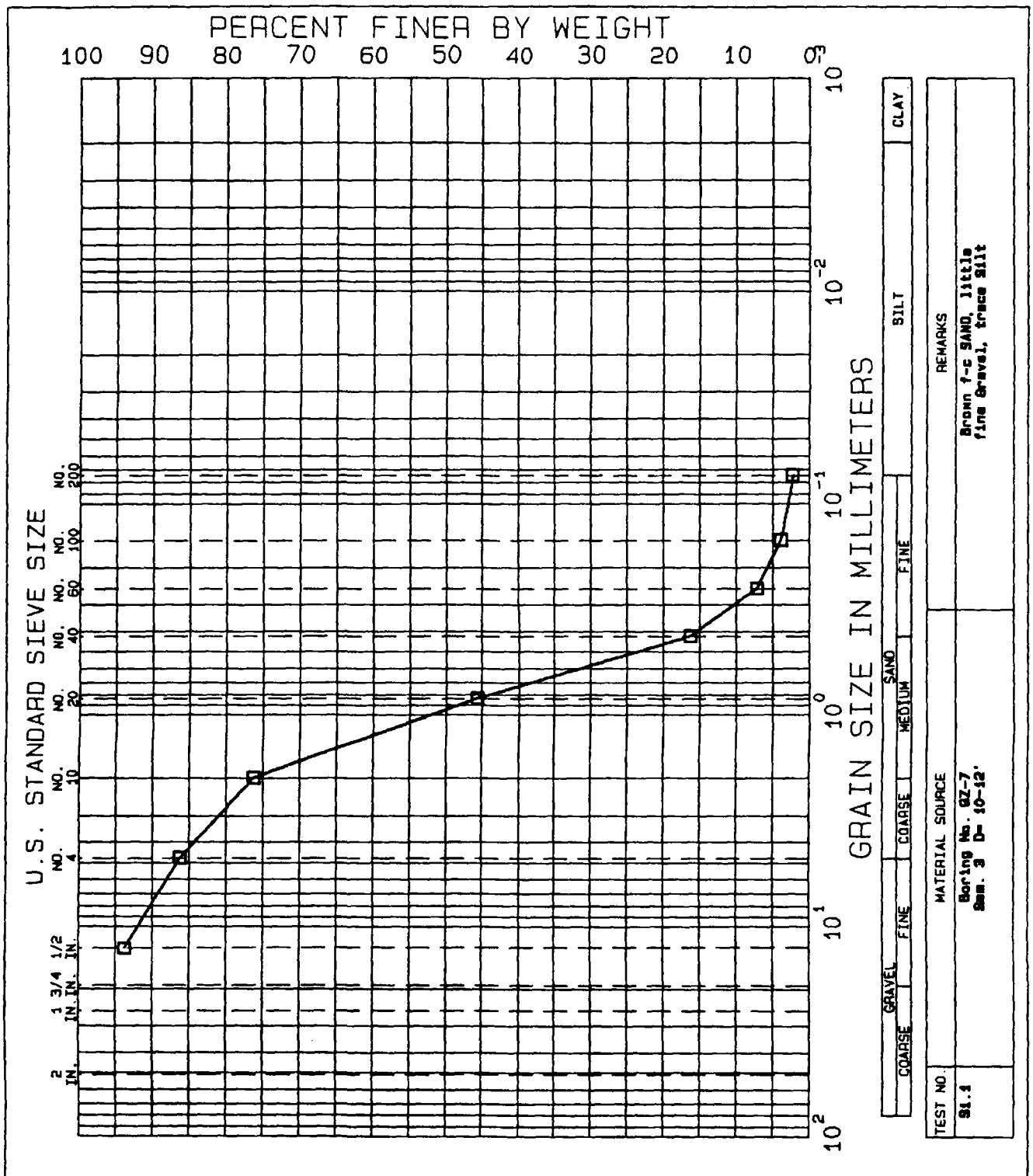




60 OLYMPIA AVE
WOBBURN, MASS
GRADATION TESTS

BORING NO. 92-9
SAMPLE 5-2
DEPTH 5-7'
TECH. SM
REVIEWER JK

TEST SERIES
NO. 2
DATE April 11 90
FILE 46596.2



APPENDIX L
TOXICITY PROFILES

BENZENE

I. CHEMICAL AND PHYSICAL INFORMATION

A. Chemical Name: Benzene

B. Synonyms: (6)-Annulene, benzol, benzolene, carbon oil, coal naphtha, cyclonexatriene, mineral naphtha, motor benzol, phene.

C. Trade Names: Polystream.

D. CAS No.: 71-43-2

E. Molecular Formula: C_6H_6

F. Structural Formula:



G. Molecular Weight: 78.1

H. Physical Properties:

1. Physical State: Liquid (Windholz, 1983).
2. Color: Colorless (Windholz, 1983).
3. Odor/Odor Threshold: Recognition: 10.5 to 210 mg/m^3 , distinct odor: 310 mg/m^3 (Verschuieren, 1983).
4. Melting Point: $+5.5^\circ C$ (solidification point) (Windholz, 1983).
5. Boiling Point: $80.1^\circ C$ (Windholz, 1983).
6. Flash Point: $12^\circ F$ ($-11^\circ C$) (closed cup) (Windholz, 1983).
7. Autoignition Temperature: $1,040^\circ F$ ($560^\circ C$) (Baker, 1978).
8. Flammability Limits: 1.3 to 7.1% (Baker, 1978).
9. Vapor Pressure: 60 mm Hg @ $15^\circ C$; 76 mm Hg @ $20^\circ C$; 118 mm Hg @ $30^\circ C$ (Verschuieren, 1983).
10. Specific Gravity: 0.87686 at $20^\circ C$ referred to water at $4^\circ C$ (Verschuieren, 1983).
11. Vapor Density: 2.77 (air = 1) (Verschuieren, 1983).
12. Refractive Index: $n_D^{20} = 1.50108$ (Windholz, 1983).

13. Solubility in Water: 1.780 mg/L at 20°C (Verschuieren, 1983).
14. Solubility in Organic Solvents: Miscible with alcohol, chloroform, ether, carbon disulfide, carbon tetrachloride, glacial acetic acid, acetone, oils (Windholz, 1983).
15. Log Partition Coefficient: 2.13 (octanol/water) (Verschuieren, 1983).
16. Henry's Law Constant: 5.5×10^{-5} atm m³/mol (Thomas, 1982).
17. Other: Highly flammable (Windholz, 1983).

II. ENVIRONMENTAL FATE

- A. Air: Benzene will undergo some photodegradation in the atmosphere. Gaseous benzene absorbs light at ≤ 275 nm and, because the ozone layer filters out light with wave lengths below 290 nm, it is unlikely that direct photolysis of benzene will occur in the troposphere (Noyes et al., 1966). Photooxidation appears to be a relatively slow degradative pathway for benzene; in bright sunlight and in a polluted atmosphere with a high concentration of hydroxyl radicals, the half-life may be 16 hours, and may reach 167 hours at less than optimal conditions (Darnall et al., 1976). Smog chamber experiments have shown that 100 ppm benzene irradiated with 230 nm light degrades by 31.5% in 2 hours (Hustert and Parlar, 1981). Karte and Klein (1982) concluded that atmospheric benzene will photodegrade in the presence of active species such as NO_x with a half-life of approximately 1 day, with 2 days necessary for 50% degradation to CO₂.

A mixture of jet fuel containing benzene in water showed no significant photodegradation when exposed to sunlight for 21 days (Smith and Harper, 1982) although Hustert et al. (1981) reported a half-life of 17 days for benzene in water.

- B. Soil: Benzene has a low to moderate potential for adsorption to soils with a K_{oc} of 30-60 (Chiou et al., 1983). With a log octanol/water partition coefficient of 2.15 it is unlikely to sorb to organic matter in soil but will pass through to the groundwater or evaporate to the atmosphere (Briggs, 1977). This lack of adsorption can result in significant transport of benzene through soil into groundwater and diffusion throughout the aquatic environment. When benzene (0.01-1.0 mg/L) was applied to montmorillonite clay containing virtually no organic material, only 4% of the benzene was adsorbed (Rogers et al., 1980).

The biodegradation of benzene can be quite rapid under optimal aerobic conditions in soil or water, particularly with acclimated

after cessation of exposure. Benzene is most rapidly metabolized by liver microsomes where it is converted primarily to phenol, catechol, and quinol. In humans exposed to 80-100 µg/L of benzene for 6 hours, approximately 230 mg was retained. Up to 50-87% of the retained dose was excreted in the urine as phenol, and 12% was eliminated unchanged from the lung (Hunter and Blair, 1972). The rate of metabolism is dose-dependent and may be affected by the presence of compounds such as phenobarbital that stimulate or others that inhibit metabolism.

Chronic benzene exposure produces bone marrow abnormalities. It has been suggested that the active toxic metabolite may be transported from the liver to the bone marrow or formed in bone marrow itself. Benzene oxide has been cited as a metabolite capable of disrupting DNA and RNA synthesis. Benzene oxide may be formed by oxidation by cytochrome P450 and mixed function oxidase in liver microsomes (Snyder and Kocsis, 1975).

IV. TOXICITY

- A. Acute toxicity: The acute oral LD₅₀ for rats is between 3.4 and 5.9 g/kg (IARC, 1982), 4.7 g/kg for mice and 2.0 g/kg for dogs (RTECS, 1986). The acute inhalation LC₅₀ for rats is 13,700 ppm, and 9,980 ppm for mice (RTECS, 1986). Intraperitoneally, the LD₅₀'s are 990 µg/kg for mice and 2,890 µg/kg for rats, with toxic effects seen in the blood, pulmonary system and liver (RTECS, 1986).

A dermal dose of 15 mg/24 hours in an open skin irritation test in rabbits produced mild irritant effects; exposure to 2 mg for 24 hours was severely irritating to the rabbit eye (RTECS, 1986).

In humans, benzene produces acute toxic effects on the nervous system. Exposure to concentrations of 2.5% by volume in air are rapidly fatal, causing convulsions, central nervous system depression and death from cardiovascular collapse. Prolonged exposure to lower concentrations produces euphoria, giddiness, headache, nausea, staggering and eventual unconsciousness (NRC, 1976).

- B. Chronic toxicity: Chronic exposure to benzene leads to bone marrow depression in experimental animals. Leukopenia has been reported in rabbits, rats and guinea pigs at exposures of 88 ppm for 7 hours/day for up to 269 days and in rabbits exposed to 240 ppm benzene for 10 hours/day for 2 weeks. However, animals exposed to 17.6 ppm for 127 days showed no blood effects (IARC, 1982). Sprague-Dawley rats and AKR mice exposed to 300 ppm benzene for 6 hours/day, 5 days/week for life exhibited lymphocytopenia but little anemia while lifetime exposure of C57BL/65 mice to 100 or 300 ppm benzene resulted in anemia, lymphocytopenia and neutrophilia (IARC, 1982). Bilateral cataracts were found in 50% of rats exposed to 50 ppm benzene for 600 hours (NRC, 1977).

Chromosomal aberrations such as chromosome breaks, dicentric chromosomes, translocations and exchange figures were found in the lymphocytes of 52 workers exposed to benzene (8-hour time-weighted average concentration of 2-3 ppm) at 2-3 times the rates found in unexposed controls (Kilian and Danial, 1978). A cytogenic study of 22 healthy subjects engaged in benzene production at exposure levels of 0.2-12.4 ppm showed no increase in sister chromatid exchange; however, a significantly higher percentage of structural chromosomal aberrations was observed (Sarto et al., 1984).

- E. Developmental and Reproductive Toxicity: Benzene has been shown to be fetotoxic and embryoethal and somewhat teratogenic in laboratory animals. Rats exposed to 500 ppm benzene for 7 hours/day on gestation days 6 through 15 had increased numbers of fetal malformations including exencephaly, angulated ribs, brain defects, and out-of-sequence ossification (Kuna and Kapp, 1981). Green et al. (1978) also found delayed ossification of sternebrae in fetuses of pregnant Sprague-Dawley rats exposed to 300 and 2,200 ppm benzene vapor for 6 hours daily on days 6 through 15 of gestation. In other studies, pregnant mice exposed to 2 or 4 mL/kg benzene subcutaneously, 0.3 to 1.0 mL/kg orally or 500 ppm by inhalation for 7 hours/day showed no teratogenic effects although reduced fetal weight and occasional embryoethality were seen (IARC, 1982).

Benzene has been found to affect the reproductive organs in adult animals. Rats, guinea pigs and rabbits exposed to 80-88 ppm benzene for 7 hours/day for 30 to 40 weeks showed degeneration of the seminiferous tubules and increased testicular weight (Wolf et al., 1956). Female rats exposed to 1.6 or 9.4 ppm benzene for 4 months had altered estrous cycles but no subsequent effects on fertility or litter size were reported (Avilova and Ulanova, 1975).

V. ENVIRONMENTAL STANDARDS AND CRITERIA

A. Air:

ACGIH: TWA of 10 ppm (30 mg/m³); Short-Term Exposure Limit 25 ppm (75 mg/m³).

OSHA: OSHA air standard TWA of 10 ppm; ceiling concentration of 25 ppm; peak concentration of 50 ppm/10 min/8 h; meets criteria for proposed OSHA Medical Records Rule.

Clean Air Act Section 112:

Benzene emissions from process vents of new ethylbenzene or styrene plants are limited to 5 ppm by volume.

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ETHYLBENZENE

Summary

There is some evidence suggesting that ethylbenzene causes adverse reproductive effects in animals. Oral and inhalation exposure caused minor liver and kidney changes in rats. Ethylbenzene is a skin and eye irritant.

CAS Number: 100-41-4

Chemical Formula: $C_6H_5C_2H_5$

IUPAC Name: Ethylbenzene

Important Synonyms and Trade Names: Phenylethane, EB, ethylbenzol

Chemical and Physical Properties

Molecular Weight: 106.2

Boiling Point: 136.2°C

Melting Point: -95°C

Specific Gravity: 0.867 at 20°C (liquid)

Solubility in Water: 161 mg/liter at 25°C

Solubility in Organics: Freely soluble in organic solvents

Log Octanol/Water Partition Coefficient: 3.15

Vapor Pressure: 7 mm Hg at 20°C

Vapor Density: 3.66

Henry's Law Constant: 6.44 atm. m³/mole

Flash Point: 17.2°C

Transport and Fate

Only limited data are available on the transport and fate of ethylbenzene. Volatilization is probably the major route of elimination from surface water. Subsequent atmospheric reactions, especially photooxidation, are responsible for its

Ethylbenzene

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 Clement Associates

fate. However, its high log octanol/water partition coefficient suggests that a significant amount of ethylbenzene may be adsorbed by organic material in the sediment. Some soil bacteria are capable of using ethylbenzene as a source of carbon. However, the relative importance of this potential route of ethylbenzene elimination has not been determined.

Health Effects

Ethylbenzene has been selected by the National Toxicology Program to be tested for possible carcinogenicity, although negative results were obtained in mutagenicity assays in Salmonella typhimurium and Saccharomyces cerevisiae. There is recent animal evidence that ethylbenzene causes adverse reproductive effects. Ethylbenzene is a skin irritant, and its vapor is irritating to the eyes at a concentration of 200 ppm (870 mg/m³) and above. When experimental animals were exposed to ethylbenzene by inhalation, 7 hours/day for 6 months, adverse effects were produced at concentrations of 500 ppm (2,610 mg/m³) and above, but not at 400 ppm (1,740 mg/m³). At 600 ppm rats and guinea pigs showed slight changes in liver and kidney weights, monkeys had slight changes in liver weight, and monkeys and rabbits experienced histopathologic changes in the testes. Similar effects on the liver and kidney were observed in rats fed ethylbenzene at 408 and 680 mg/kg/day for 6 months.

Toxicity to Wildlife and Domestic Animals

Ethylbenzene was acutely toxic to freshwater species at levels greater than 32 mg/liter. No chronic toxicity was reported, but the highest test dose (440 µg/liter) was only one-hundredth of the 96-hour LC₅₀ for the particular species being tested. No studies on the bioaccumulation of ethylbenzene were reported in the information reviewed, but a bioconcentration factor of 95 was calculated using the log octanol/water partition coefficient. No information on the toxicity of ethylbenzene to domestic animals and terrestrial wildlife was found in the sources reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing final criteria. However, EPA did report the lowest values known to have toxic effects in aquatic organisms.

APPENDIX L
TOXICITY PROFILES

BENZENE

I. CHEMICAL AND PHYSICAL INFORMATION

A. Chemical Name: Benzene

B. Synonyms: (6)-Annulene, benzol, benzolene, carbon oil, coal naphtha, cyclonexatriene, mineral naphtha, motor benzol, phene.

C. Trade Names: Polystream.

D. CAS No.: 71-43-2

E. Molecular Formula: C_6H_6

F. Structural Formula:



G. Molecular Weight: 78.1

H. Physical Properties:

1. Physical State: Liquid (Windholz, 1983).
2. Color: Colorless (Windholz, 1983).
3. Odor/Odor Threshold: Recognition: 10.5 to 210 mg/m^3 , distinct odor: 310 mg/m^3 (Verschueren, 1983).
4. Melting Point: $+5.5^\circ C$ (solidification point) (Windholz, 1983).
5. Boiling Point: $80.1^\circ C$ (Windholz, 1983).
6. Flash Point: $12^\circ F$ ($-11^\circ C$) (closed cup) (Windholz, 1983).
7. Autoignition Temperature: $1,040^\circ F$ ($560^\circ C$) (Baker, 1978).
8. Flammability Limits: 1.3 to 7.1% (Baker, 1978).
9. Vapor Pressure: 60 mm Hg @ $15^\circ C$; 76 mm Hg @ $20^\circ C$; 118 mm Hg @ $30^\circ C$ (Verschueren, 1983).
10. Specific Gravity: 0.87686 at $20^\circ C$ referred to water at $4^\circ C$ (Verschueren, 1983).
11. Vapor Density: 2.77 (air = 1) (Verschueren, 1983).
12. Refractive Index: $n_D^{20} = 1.50108$ (Windholz, 1983).

13. Solubility in Water: 1.780 mg/L at 20°C (Verschuieren, 1983).
14. Solubility in Organic Solvents: Miscible with alcohol, chloroform, ether, carbon disulfide, carbon tetrachloride, glacial acetic acid, acetone, oils (Windholz, 1983).
15. Log Partition Coefficient: 2.13 (octanol/water) (Verschuieren, 1983).
16. Henry's Law Constant: 5.5×10^{-5} atm m³/mol (Thomas, 1982).
17. Other: Highly flammable (Windholz, 1983).

II. ENVIRONMENTAL FATE

- A. Air: Benzene will undergo some photodegradation in the atmosphere. Gaseous benzene absorbs light at ≤ 275 nm and, because the ozone layer filters out light with wave lengths below 290 nm, it is unlikely that direct photolysis of benzene will occur in the troposphere (Noyes et al., 1966). Photooxidation appears to be a relatively slow degradative pathway for benzene; in bright sunlight and in a polluted atmosphere with a high concentration of hydroxyl radicals, the half-life may be 16 hours, and may reach 167 hours at less than optimal conditions (Darnall et al., 1976). Smog chamber experiments have shown that 100 ppm benzene irradiated with 230 nm light degrades by 31.5% in 2 hours (Hustert and Parlar, 1981). Karte and Klein (1982) concluded that atmospheric benzene will photodegrade in the presence of active species such as NO_x with a half-life of approximately 1 day, with 2 days necessary for 50% degradation to CO₂.

A mixture of jet fuel containing benzene in water showed no significant photodegradation when exposed to sunlight for 21 days (Smith and Harper, 1982) although Hustert et al. (1981) reported a half-life of 17 days for benzene in water.

- B. Soil: Benzene has a low to moderate potential for adsorption to soils with a K_{oc} of 30-60 (Chiou et al., 1983). With a log octanol/water partition coefficient of 2.15 it is unlikely to sorb to organic matter in soil but will pass through to the groundwater or evaporate to the atmosphere (Briggs, 1977). This lack of adsorption can result in significant transport of benzene through soil into groundwater and diffusion throughout the aquatic environment. When benzene (0.01-1.0 mg/L) was applied to montmorillonite clay containing virtually no organic material, only 4% of the benzene was adsorbed (Rogers et al., 1980).

The biodegradation of benzene can be quite rapid under optimal aerobic conditions in soil or water, particularly with acclimated

microorganisms. Biodegradation of benzene does not occur in an anaerobic environment (Horowitz et al., 1982). The soil microbes Nocardia and Pseudomonas, were able to degrade 20 µg/mL benzene to CO₂ by 85% and 45 to 90%, respectively, in one week (Haider et al., 1974). Twenty ppm benzene in soil was degraded by 24% in 1 week, 44% in 5 weeks and 47% in 10 weeks.

- C. Water: Benzene does not react with water at environmental temperatures in the pH range of 2 to 14 (Mara and Lee, 1978). The oxidation of benzene in aquatic or atmospheric systems results in the formation, variously, of phenol, 2-nitrophenol, 4-nitrophenol, 2,4-dinitrophenol, 2,6-dinitrophenol, nitrobenzene, formic acid and peroxyacetyl nitrate (Nojima et al., 1975).

Degradation in aquatic ecosystems is affected by water temperature. When 0.2 to 4 µg/L benzene was added to seawater under summer or spring conditions, biodegradation was 100% complete in 2 days after a 2-week or 2-day acclimation period, respectively, but no biodegradation occurred under winter conditions. The half-life of benzene was 3.1 days in summer and 13 days in winter (Wakeham et al., 1983).

- D. Bioconcentration: There is little or no bioconcentration potential for benzene, calculated bioconcentration factor (BCF) of 25 (Veith et al., 1979).

III. EXPOSURE AND BIOLOGICAL DISPOSITION

- A. Routes of Exposure: Benzene is easily absorbed both orally and by inhalation and is less readily absorbed through the skin.
- B. Bioavailability: Benzene is 100% absorbed when injected in animals. Complete absorption has been demonstrated in rats (Zbarsky and Young, 1943) guinea pigs (Gibson et al., 1974), mice (Snyder et al., 1982) and rabbits (Parke and Williams, 1953). Dermal absorption of benzene was 0.28% of the applied dose in hairless mice (Susten et al., 1985), 0.09% of the applied dose in the mini-pig (Franz, 1984), and up to 0.65% in monkeys (Maibach and Anjo, 1981).

Dermal absorption rates in humans reported for benzene range from 0.4 mg/m²/cm²/h (Hanke et al., 1961) to 1.85 mg/cm²/h (Blank and McAuliffe, 1985). The human respiratory absorption of inhaled benzene has been found to be 40-50% retained at exposures up to 110 ppm (Srbova et al., 1950; Teisinger et al., 1952; Duvoir et al., 1946).

- C. Pharmacology: Benzene is preferentially taken up by fatty and nervous tissue. It is relatively insoluble in body fluids and is virtually completely eliminated via lungs and kidneys shortly

after cessation of exposure. Benzene is most rapidly metabolized by liver microsomes where it is converted primarily to phenol, catechol, and quinol. In humans exposed to 80-100 µg/L of benzene for 6 hours, approximately 230 mg was retained. Up to 50-87% of the retained dose was excreted in the urine as phenol, and 12% was eliminated unchanged from the lung (Hunter and Blair, 1972). The rate of metabolism is dose-dependent and may be affected by the presence of compounds such as phenobarbital that stimulate or others that inhibit metabolism.

Chronic benzene exposure produces bone marrow abnormalities. It has been suggested that the active toxic metabolite may be transported from the liver to the bone marrow or formed in bone marrow itself. Benzene oxide has been cited as a metabolite capable of disrupting DNA and RNA synthesis. Benzene oxide may be formed by oxidation by cytochrome P450 and mixed function oxidase in liver microsomes (Snyder and Kocsis, 1975).

IV. TOXICITY

- A. Acute toxicity: The acute oral LD₅₀ for rats is between 3.4 and 5.9 g/kg (IARC, 1982), 4.7 g/kg for mice and 2.0 g/kg for dogs (RTECS, 1986). The acute inhalation LC₅₀ for rats is 13,700 ppm, and 9,980 ppm for mice (RTECS, 1986). Intraperitoneally, the LD₅₀'s are 990 µg/kg for mice and 2,890 µg/kg for rats, with toxic effects seen in the blood, pulmonary system and liver (RTECS, 1986).

A dermal dose of 15 mg/24 hours in an open skin irritation test in rabbits produced mild irritant effects; exposure to 2 mg for 24 hours was severely irritating to the rabbit eye (RTECS, 1986).

In humans, benzene produces acute toxic effects on the nervous system. Exposure to concentrations of 2.5% by volume in air are rapidly fatal, causing convulsions, central nervous system depression and death from cardiovascular collapse. Prolonged exposure to lower concentrations produces euphoria, giddiness, headache, nausea, staggering and eventual unconsciousness (NRC, 1976).

- B. Chronic toxicity: Chronic exposure to benzene leads to bone marrow depression in experimental animals. Leukopenia has been reported in rabbits, rats and guinea pigs at exposures of 88 ppm for 7 hours/day for up to 269 days and in rabbits exposed to 240 ppm benzene for 10 hours/day for 2 weeks. However, animals exposed to 17.6 ppm for 127 days showed no blood effects (IARC, 1982). Sprague-Dawley rats and AKR mice exposed to 300 ppm benzene for 6 hours/day, 5 days/week for life exhibited lymphocytopenia but little anemia while lifetime exposure of C57BL/65 mice to 100 or 300 ppm benzene resulted in anemia, lymphocytopenia and neutrophilia (IARC, 1982). Bilateral cataracts were found in 50% of rats exposed to 50 ppm benzene for 600 hours (NRC, 1977).

Chronic human exposure to benzene may result in purpura, thrombocytopenia, anemia or a combination of these. However, these effects may be reversible in the early stages. Prolonged exposure may eventually lead to pancytopenia which is considered to be irreversible (IARC, 1982).

- C. Carcinogenicity: Benzene appears to be an inducer of leukemia and anemia in humans but evidence of its carcinogenic potential in animals is inadequate. Oral administration of 50 or 250 mg/kg benzene in olive oil to 30 female and 30 male Sprague-Dawley rats once daily, 4-5 times per week for 1 year resulted in 2 ymbal gland carcinomas in 8 female rats at the high dose and 2 female rats at the low dose; increased incidence of mammary gland carcinomas were found in females and increased leukemias were found in both male and female rats (Maltoni and Scarnato, 1979). In a chronic inhalation study, 40 male C57BL mice exposed to 300 ppm benzene, 6 hours/day, 5 days a week for life exhibited anemia and other blood disorders and 6 of the 40 mice developed lymphocytic lymphoma, one developed plasmacytoma and one leukemia (Snyder et al., 1980). Ward et al. (1975) found no evidence of carcinogenic activity in male C57BL/6N mice given subcutaneous injections of a 30% solution of benzene in corn oil twice weekly for 44 weeks and then once weekly for 54 weeks.

Several studies have indicated that worker exposure to benzene can lead to an increased incidence of leukemia and aplastic anemia (Snyder et al., 1977). Aksoy et al. (1974) and Aksoy (1977) studied the incidence of acute leukemia or "preleukemia" in 28,500 Turkish shoemakers. Maximum exposures were estimated to be 210-650 ppm for 1 to 15 years (mean 9.7 years). The annual incidence of cancer was estimated to be 13/100,000 giving a risk of 2 compared with the general population. An historical cohort study of 259 male workers at a chemical plant where large quantities of benzene had been used indicated that of 58 known deaths there were 4 deaths from lymphoreticular cancer (vs. 1.1 expected), 3 deaths from leukemia and 1 death from multiple myeloma, again suggesting that occupational exposure to benzene is linked to leukemia (Decoufle et al., 1983).

- D. Mutagenicity: Benzene is not mutagenic in several systems: in Salmonella typhimurium strains TA 98 and TA 100 with or without metabolic activation (Lyon, 1976); in Bacillus subtilis (Tanooka, 1977); in the sex-linked recessive lethal assay in Drosophila melanogaster (Nylander et al., 1978); and in the mouse lymphoma forward mutation assay (Lebowitz et al., 1979). The effect of benzene at up to 250 µg/L on human lymphocytes is unclear. Some chromatid-type deletions and gaps were found in vitro, with cells in the late G2 phase most susceptible (Morimoto, 1976). Benzene may increase the frequency of sister chromatid exchange during the first 24 hours of culture but not later (Díaz et al., 1979). Two doses of 0.05 to 0.5 mL/kg per day of benzene administered intraperitoneally to rats caused an increase in polychromatic erythrocytes with micronuclei (Lyon, 1976).

Chromosomal aberrations such as chromosome breaks, dicentric chromosomes, translocations and exchange figures were found in the lymphocytes of 52 workers exposed to benzene (8-hour time-weighted average concentration of 2-3 ppm) at 2-3 times the rates found in unexposed controls (Kilian and Danial, 1978). A cytogenetic study of 22 healthy subjects engaged in benzene production at exposure levels of 0.2-12.4 ppm showed no increase in sister chromatid exchange; however, a significantly higher percentage of structural chromosomal aberrations was observed (Sarto et al., 1984).

- E. Developmental and Reproductive Toxicity: Benzene has been shown to be fetotoxic and embryolethal and somewhat teratogenic in laboratory animals. Rats exposed to 500 ppm benzene for 7 hours/day on gestation days 6 through 15 had increased numbers of fetal malformations including exencephaly, angulated ribs, brain defects, and out-of-sequence ossification (Kuna and Kapp, 1981). Green et al. (1978) also found delayed ossification of sternebrae in fetuses of pregnant Sprague-Dawley rats exposed to 300 and 2,200 ppm benzene vapor for 6 hours daily on days 6 through 15 of gestation. In other studies, pregnant mice exposed to 2 or 4 mL/kg benzene subcutaneously, 0.3 to 1.0 mL/kg orally or 500 ppm by inhalation for 7 hours/day showed no teratogenic effects although reduced fetal weight and occasional embryolethality were seen (IARC, 1982).

Benzene has been found to affect the reproductive organs in adult animals. Rats, guinea pigs and rabbits exposed to 80-88 ppm benzene for 7 hours/day for 30 to 40 weeks showed degeneration of the seminiferous tubules and increased testicular weight (Wolf et al., 1956). Female rats exposed to 1.6 or 9.4 ppm benzene for 4 months had altered estrous cycles but no subsequent effects on fertility or litter size were reported (Avilova and Ulanova, 1975).

V. ENVIRONMENTAL STANDARDS AND CRITERIA

A. Air:

ACGIH: TWA of 10 ppm (30 mg/m³); Short-Term Exposure Limit 25 ppm (75 mg/m³).

OSHA: OSHA air standard TWA of 10 ppm; ceiling concentration of 25 ppm; peak concentration of 50 ppm/10 min/8 h; meets criteria for proposed OSHA Medical Records Rule.

Clean Air Act Section 112:

Benzene emissions from process vents of new ethylbenzene or styrene plants are limited to 5 ppm by volume.

B. Groundwater:

No information was found.

C. Surface Water:

No information was found.

D. Drinking water:

EPA: Proposed Maximum Contaminant Level: 5 ppb
Maximum Contaminant Level Goal: 0
Health Advisory (acute): 233 ppb
Health Advisory (chronic, cancer): 0.35 ppb
Ambient Water Quality Criteria (cancer): 0.66 ppb
(aquatic organisms and drinking water): 0.67 ppb
(adjusted for drinking water only)

E. Other:

CERCLA: Reportable quantity 1000 lb (454 kg).

RCRA: Waste No. U019

CAG: Group A carcinogen

Risk Characterization for Potential Carcinogenic Effects:

Oral route: Potency factor $5.20\text{E-}02$ per mg/kg/day; EPA weight of evidence, A

Inhalation route: Potency factor $2.60\text{E-}1$ per mg/kg/day; EPA weight of evidence, A

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ETHYLBENZENE

Summary

There is some evidence suggesting that ethylbenzene causes adverse reproductive effects in animals. Oral and inhalation exposure caused minor liver and kidney changes in rats. Ethylbenzene is a skin and eye irritant.

CAS Number: 100-41-4

Chemical Formula: $C_6H_5C_2H_5$

IUPAC Name: Ethylbenzene

Important Synonyms and Trade Names: Phenylethane, EB, ethylbenzol

Chemical and Physical Properties

Molecular Weight: 106.2

Boiling Point: 136.2°C

Melting Point: -95°C

Specific Gravity: 0.867 at 20°C (liquid)

Solubility in Water: 161 mg/liter at 25°C

Solubility in Organics: Freely soluble in organic solvents

Log Octanol/Water Partition Coefficient: 3.15

Vapor Pressure: 7 mm Hg at 20°C

Vapor Density: 3.66

Henry's Law Constant: 6.44 atm. m³/mole

Flash Point: 17.2°C

Transport and Fate

Only limited data are available on the transport and fate of ethylbenzene. Volatilization is probably the major route of elimination from surface water. Subsequent atmospheric reactions, especially photooxidation, are responsible for its

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fate. However, its high log octanol/water partition coefficient suggests that a significant amount of ethylbenzene may be adsorbed by organic material in the sediment. Some soil bacteria are capable of using ethylbenzene as a source of carbon. However, the relative importance of this potential route of ethylbenzene elimination has not been determined.

Health Effects

Ethylbenzene has been selected by the National Toxicology Program to be tested for possible carcinogenicity, although negative results were obtained in mutagenicity assays in Salmonella typhimurium and Saccharomyces cerevisiae. There is recent animal evidence that ethylbenzene causes adverse reproductive effects. Ethylbenzene is a skin irritant, and its vapor is irritating to the eyes at a concentration of 200 ppm (870 mg/m³) and above. When experimental animals were exposed to ethylbenzene by inhalation, 7 hours/day for 6 months, adverse effects were produced at concentrations of 600 ppm (2,610 mg/m³) and above, but not at 400 ppm (1,740 mg/m³). At 600 ppm rats and guinea pigs showed slight changes in liver and kidney weights, monkeys had slight changes in liver weight, and monkeys and rabbits experienced histopathologic changes in the testes. Similar effects on the liver and kidney were observed in rats fed ethylbenzene at 408 and 680 mg/kg/day for 6 months.

Toxicity to Wildlife and Domestic Animals

Ethylbenzene was acutely toxic to freshwater species at levels greater than 32 mg/liter. No chronic toxicity was reported, but the highest test dose (440 µg/liter) was only one-hundredth of the 96-hour LC₅₀ for the particular species being tested. No studies on the bioaccumulation of ethylbenzene were reported in the information reviewed, but a bioconcentration factor of 95 was calculated using the log octanol/water partition coefficient. No information on the toxicity of ethylbenzene to domestic animals and terrestrial wildlife was found in the sources reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing final criteria. However, EPA did report the lowest values known to have toxic effects in aquatic organisms.

Freshwater

Acute toxicity: 32,000 µg/liter

Chronic toxicity: No available data

Saltwater

Acute toxicity: 430 µg/liter

Chronic toxicity: No available data

Human Health

Criterion: 1.4 mg/liter

OSHA Standard (skin): 435 mg/m³ TWA

ACGIH Threshold Limit Values: 435 mg/m³ TWA
545 mg/m³ STEL

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NAPHTHALENE

Summary

Naphthalene retarded cranial ossification and heart development in the offspring of exposed pregnant rats. Inhalation exposure caused nausea, headache, and optic and kidney damage in humans and experimental animals. Oral administration produced cataracts in rabbits and induced changes in motor activity in rats and mice. Exposure to high doses of naphthalene cause severe hemolytic effects.

CAS Number: 91-20-3

Chemical Formula: $C_{10}H_8$

IUPAC Name: Naphthalene

Important Synonyms and Trade Names: Naphthene, tar camphor, moth balls

Chemical and Physical Properties

Molecular Weight: 128.16

Boiling Point: 217.9°C

Melting Point: 80.2°C

Specific Gravity: 1.152 at 20°C

Solubility in Water: 34.4 mg/liter at 25°C

Solubility in Organics: Soluble in alcohol, ether, acetone, and benzene

Log Octanol/Water Partition Coefficient: 3.37

Vapor Pressure: 0.087 mm Hg at 25°C

Vapor Density: 4.42

Transport and Fate

Environmental transport and fate is largely inferred from data for polycyclic aromatic hydrocarbons (PAHs) in general, because specific information for naphthalene is lacking. Rapid, direct photolysis of naphthalene to quinones may be an important

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process in surface waters. Oxidation is probably too slow to be a significant environmental process. However, data for some PAHs suggest that oxidation by chlorine or ozone may be a significant fate process when these oxidants are available in sufficient quantity. Volatilization may play a role in transport depending on mixing rates in both the water column and air column. For naphthalene, adsorption is the most important aquatic transport process. Consideration of its log octanol/water partition coefficient and of the behavior of other PAHs indicate that naphthalene can be strongly adsorbed onto suspended and sedimentary particulate matter, especially particulates high in organic content. Dominance of volatilization or absorption as a transport process is directly related to environmental conditions. It is likely that this compound can be readily transported as adsorbed matter or suspended particulates in air or water.

Based on information concerning related compounds, it is likely that bioaccumulation of naphthalene is short term, especially for vertebrates. Although this compound is rapidly accumulated, it also is rapidly metabolized and excreted, and consequently bioaccumulation is not considered an important fate process. Naphthalene can be metabolized by multicellular organisms and degraded by microbes. Degradation by mammals is likely to be incomplete, with parent compound and the metabolites being excreted by the urinary system. Biodegradation by microorganisms is probably the ultimate fate process for naphthalene. Biodegradation generally appears to be more efficient in soil than in aquatic systems. However, experimental data indicate that biodegradation may be more important in those aquatic systems which are chronically affected by PAH contamination.

Atmospheric transport of PAHs can occur, and these materials can be returned to aquatic and terrestrial systems by wet and dry deposition. Some PAHs may enter surface and groundwaters by leaching from polluted soils.

Health Effects

There are no epidemiological or case studies available suggesting that naphthalene is carcinogenic in humans. This compound is not generally considered to be carcinogenic in experimental animals. However, there is equivocal evidence suggesting weak carcinogenic activity in rats after subcutaneous injection. Naphthalene is reported to produce DNA damage in mice after intraperitoneal injection. Retarded cranial ossification and heart development are reported among offspring of rats injected intraperitoneally with naphthalene on days 1 to 15 of gestation.

Little information concerning acute and chronic toxic effects is available. Inhalation exposure to naphthalene may cause headache, loss of appetite, nausea, and kidney damage in humans and experimental animals. Acute hemolytic effects are reportedly caused by ingestion or inhalation of relatively large quantities of naphthalene. Optical neuritis, injuries to the cornea, and opacities of the lens also may result after inhalation exposure or ingestion. Naphthalene is a mild eye irritant in rabbits, and cataracts can be induced after oral administration. Application to the skin produces erythema and slight edema in rabbits. Somnolence and changes in motor activity are observed after ingestion of naphthalene by rats and mice. Oral LD₅₀ values of 1,250 mg/kg and 580 mg/kg are reported for the rat and the mouse, respectively.

Toxicity to Wildlife and Domestic Animals

The median effect concentrations for freshwater invertebrate species and three fish species are all reported to be greater than 2,300 µg/liter. Acute values reported for saltwater polychaete, oyster, and shrimp species are all greater than 2,350 µg/liter. A chronic value of 620 µg/liter and an acute-chronic ratio of 11 is reported for the fathead minnow, a freshwater species. No chronic values are available for saltwater species. Freshwater algae appear to be less sensitive to the effects of naphthalene than animal species. No information concerning saltwater plant species is available. The weighted average bioconcentration factor for the edible portion of all freshwater and estuarine aquatic organisms consumed by Americans is 10.5.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

The available data are not adequate for establishing criteria.

OSHA Standard: 50 mg/m³ TWA

ACGIH Threshold Limit Values: 50 mg/m³ TWA
75 mg/m³ STEL

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TOLUENE

Summary

Toluene has been shown to be embryotoxic in experimental animals, and the incidence of cleft palate increased in the offspring of dosed mice. Chronic inhalation exposure to high levels of toluene caused cerebellar degeneration and an irreversible encephalopathy in animals. In humans, acute exposure depressed the central nervous system and caused narcosis.

CAS Number: 108-88-3

Chemical Formula: $C_6H_5CH_3$

IUPAC Name: Methylbenzene

Important Synonyms and Trade Names: Toluol, phenylmethane

Chemical and Physical Properties

Molecular Weight: 92.13

Boiling Point: 110.6°C

Melting Point: -95°C

Specific Gravity: 0.8669 at 20°C

Solubility in Water: 534.8 mg/liter

Solubility in Organics: Soluble in acetone, ligroin, and carbon disulfide; miscible with alcohol, ether, benzene, chloroform, glacial acetic acid, and other organic solvents

Log Octanol/Water Partition Coefficient: 2.69

Vapor Pressure: 28.7 mm Hg at 25°C

Vapor Density: 3.14

Flash Point: 4.4°C

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Transport and Fate

Volatilization appears to be the major route of removal of toluene from aquatic environments, and atmospheric reaction of toluene probably subordinate all other fate processes (USEPA 1979). Photooxidation is the primary atmospheric fate process for toluene, and benzaldehyde is reported to be the principal organic product. Subsequent precipitation or dry deposition can deposit toluene and its oxidation products into aquatic and terrestrial systems. Direct photolytic cleavage of toluene is energetically improbable in the troposphere, and oxidation and hydrolysis are probably not important as aquatic fates.

The log octanol/water partition coefficient of toluene indicates that sorption processes may be significant. However, no specific environmental sorption studies are available, and the extent to which adsorption by sedimentary and suspended organic material may interfere with volatilization is unknown. Bioaccumulation is probably not an important environmental fate process. Although toluene is known to be degraded by microorganisms and can be detoxified and excreted by mammals, the available data do not allow estimation of the relative importance of biodegradation/biotransformation processes. Almost all toluene discharged to the environment by industry is in the form of atmospheric emissions.

Health Effects

There is no conclusive evidence that toluene is carcinogenic or mutagenic in animals or humans (USEPA 1980). The National Toxicological Program is currently conducting an inhalation carcinogenicity bioassay in rats and mice.

Oral administration of toluene at doses as low as 260 mg/kg produced a significant increase in embryonic lethality in mice (USEPA 1980). Decreased fetal weight was observed at doses as low as 434 mg/kg, and an increased incidence of cleft palate was seen at doses as low as 867 mg/kg. However, other research have reported that toluene is embryotoxic but not teratogenic in laboratory animals. There are no accounts of a teratogenic effect in humans after exposure to toluene.

Acute exposure to toluene at concentrations of 375-1,500 mg/m³ produces central nervous system depression and narcosis in humans (ACGIH 1980). However, even exposure to quantities sufficient to produce unconsciousness fail to produce residual organ damage. The rat oral LD₅₀ value and inhalation LC₅₀ value are 5,000 mg/kg and 15,000 mg/m³, respectively. Chronic inhalation exposure to toluene at relatively high concentration produces cerebellar degeneration and an irreversible encephalopathy in mammals.

Toluene in sufficient amounts appears to have the potential to alter significantly the metabolism and resulting bioactivity of certain chemicals. For example, coadministration of toluene along with benzene or styrene has been shown to suppress the metabolism of benzene or styrene in rats.

Toxicity to Wildlife and Domestic Animals

Of five freshwater species tested with toluene, the cladoceran Daphnia magna was most resistant to any acute effects (USEPA 1980). The EC_{50} and LC_{50} values for all five species range from 12,700 to 313,000 $\mu\text{g/liter}$. No chronic tests are available for freshwater species. The two freshwater algal species tested are relatively insensitive to toluene with EC_{50} values of 245,000 $\mu\text{g/liter}$ or greater being reported. For saltwater species, EC_{50} and LC_{50} values range from 3,700 $\mu\text{g/liter}$ for the bay shrimp to 1,050 mg/liter for the Pacific oyster. The chronic value in an embryo-larval test for the sheepshead minnow is reported to be between 3,200 and 7,700 $\mu\text{g/liter}$, and the acute-chronic ratio is between 55 and 97. In several saltwater algal species and kelp, effects occur at toluene concentrations from 8,000 to more than 433,000 $\mu\text{g/liter}$.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria. However, EPA did report the lowest concentrations of toluene known to be toxic in aquatic organisms.

Freshwater

Acute toxicity: 17,500 $\mu\text{g/liter}$
Chronic toxicity: No available data

Saltwater

Acute toxicity: 6,300 $\mu\text{g/liter}$
Chronic toxicity: 5,000 $\mu\text{g/liter}$

Human Health

Criterion: 14.3 mg/liter

NIOSH Recommended Standards: 375 mg/m^3 TWA
560 mg/m^3 STEL

OSHA Standards: 750 mg/m³ TWA
1,120 mg/m³ Ceiling Level

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XYLENES

Summary

Xylene has been shown to be fetotoxic in rats and mice. In humans, exposure to high concentrations of xylene adversely affects the central nervous system and irritates the mucous membranes.

Background Information

Xylene has three isomers, o-, m-, and p-xylene. These three generally have similar chemical and biological characteristics and therefore will be discussed together.

CAS Number: Mixed: 1330-20-7
m-Xylene: 108-38-3
o-Xylene: 95-47-6
p-Xylene: 106-42-3

Chemical Formula: $C_6H_4(CH_3)_2$

IUPAC Name: Dimethylbenzene

Important Synonyms and Trade Names:

Mixed xylene: Dimethylbenzene, xylol
m-Xylene: 1,3-Dimethylbenzene, m-xylol
o-Xylene: 1,2-Dimethylbenzene, o-xylol
p-Xylene: 1,4-Dimethylbenzene, p-xylol

Chemical and Physical Properties

Molecular Weight: 106.17

Boiling Point: Mixed: 137-140°C
m-Xylene: 139°C
o-Xylene: 144°C
p-Xylene: 138°C

Melting Point: m-Xylene: -48°C
o-Xylene: -25°C
p-Xylene: 13°C

Specific Gravity: 0.86

Solubility in Water: 160 mg/liter at 25°C

Solubility in Organics: Soluble in alcohol, ether, and other organic solvents

Log Octanol/Water Partition Coefficient: 3

Vapor Pressure: 10 mm Hg at 25°C

Vapor Density: 3.7

Flash Point: 25°C (closed cup)

Transport and Fate

Volatilization and subsequent photooxidation by reaction with hydroxyl radicals in the atmosphere are probably important transport and fate processes for xylene in the upper layer of soil and in aquatic environments. Products of the hydroxylation reaction include carbon dioxide, peroxyacetylnitrate (PAN), and cresol. Xylene binds to sediment in water and to organics in soils and undergoes microbial degradation. Biodegradation is probably the most important fate process in both soils and the aquatic environment. Xylenes have been shown to persist for up to 6 months in soil. Because of their low water solubility and rapid biodegradation, xylenes are unlikely to leach into groundwater in high concentrations.

Health Effects

The National Toxicology Program (NTP) is testing xylene for carcinogenicity by administering it orally to rats and mice. Although the results have not been finalized, it does not appear to be carcinogenic in rats.¹ Results have not been reported for mice. Xylene was not found to be mutagenic in a battery of short-term assays. Xylene is not teratogenic but has caused fetotoxicity in rats and mice. Acute exposure to rather high levels of xylene affects the central nervous system and irritates the mucous membranes. There is limited evidence of effects on other organ systems, but it was not possible to attribute these effects solely to xylene as other solvents were present. The oral LD₅₀ value of xylene in rats is 5,000 mg/kg.

Toxicity to Wildlife and Domestic Animals

Xylene adversely affected adult trout at concentrations as low as 3.6 mg/liter in a continuous flow system and trout

¹W.C. Eastin, NTP Chemical Manager; personal communication, 1984.

fry avoided xylene at concentrations greater than 0.1 mg/liter. The LC_{50} value in adult trout was determined to be 13.5 mg/liter. LC_{50} values for other freshwater fish were around 30 mg/liter in a static system, which probably underestimated toxicity. Only a few studies have been done on the toxicity of xylene to saltwater species. These indicated that the m- and o-xylene isomers probably have similar toxicities and are probably less toxic than p-xylene, and that saltwater species are generally more susceptible than freshwater species to the detrimental effects of xylene (LC_{50} = 10 mg/liter for m- and o-xylene and LC_{50} = 2 mg/liter for p-xylene). However, it should be stressed that these generalizations are based on limited data.

No information on the toxicity of xylenes to terrestrial wildlife and domestic animals was available in the literature reviewed. However, because of the low acute toxicity of xylenes it is unlikely that they would be toxic to wild or domestic birds and mammals.

Regulations and Standards

NIOSH Recommended Standards (air): 435 mg/m^3 TWA
870 mg/m^3 10-min Ceiling Level

OSHA Standard (air): 435 mg/m^3 TWA

REFERENCES

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CHLOROFORM

Summary

Chloroform (trichloromethane) is often produced during the chlorination of drinking water and thus is a common drinking water contaminant. It is volatile in surface waters and is not likely to be persistent in the environment. Chloroform caused an increase in kidney epithelial tumors in rats and in hepatocellular carcinomas in mice. In addition, there is suggestive evidence from epidemiological studies that exposure to chloroform and other trihalomethanes is associated with an increased incidence of bladder tumors in humans. Other toxic effects of chloroform include central nervous system depression; eye, skin, and gastrointestinal irritation; and damage to the liver, heart, and kidney.

CAS Number: 67-66-3

Chemical Formula: CHCl_3

IUPAC Name: Trichloromethane

Chemical and Physical Properties

Molecular Weight: 119.38

Boiling Point: 61.7°C

Melting Point: -63.5°C

Specific Gravity: 1.4832 at 20°C

Solubility in Water: 8,200 mg/liter at 20°C

Solubility in Organics: Soluble in acetone; miscible with alcohol, ether, benzene, and ligroin

Log Octanol/Water Partition Coefficient: 1.97

Vapor Pressure: 150.5 mm Hg at 20°C

Vapor Density: 4.12

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Transport and Fate

Volatilization into the atmosphere is the major transport process for removal of chloroform from aquatic systems (USEPA 1979). Once in the troposphere, chloroform is attacked by hydroxyl radicals with the subsequent formation of phosgene (COCl_2) and possibly chlorine oxide (ClO) radicals. Neither of these reaction products is likely to persist; phosgene is readily hydrolyzed to hydrochloric acid and carbon dioxide. Reaction with hydroxy radicals is thought to be the primary environmental fate of chloroform. However, chloroform that remains in the troposphere may return to earth in precipitation or adsorbed on particulates, and a small amount may diffuse upward to the stratosphere where it photodissociates via interaction with ultraviolet light.

Photolysis, hydrolysis, and sorption do not appear to be significant environmental fate processes for chloroform. However, sorption processes may have some importance as a removal mechanism in groundwater and soil. The log octanol/water partition coefficient indicates that this compound may bioaccumulate under conditions of constant exposure. Studies with marine organisms provide evidence for only weak to moderate bioaccumulation. Although chloroform is somewhat lipophilic and tends to be found at higher concentrations in fatty tissues, there is no evidence for biomagnification in aquatic food chains.

Health Effects

Chronic administration of chloroform by gavage is reported to produce a dose-related increase in the incidence of kidney epithelial tumors in rats and a dose-related increase in the incidence of hepatocellular carcinomas in mice (IARC 1979, USEPA 1980). Epidemiological studies suggest that higher concentrations of chloroform and other trihalomethanes in water supplies may be associated with an increased frequency of bladder cancer in humans. However, these results are not sufficient to establish causality. An increased incidence of fetal abnormalities was reported in offspring of pregnant rats exposed to chloroform by inhalation. Oral doses of chloroform that caused maternal toxicity produced relatively mild fetal toxicity in the form of reduced birth weights. There are limited data suggesting that chloroform has mutagenic activity in some test systems. However, negative results have been reported for bacterial mutagenesis assays.

Humans may be exposed to chloroform by inhalation, ingestion, or skin contact. Toxic effects include local irritation of the skin or eyes, central nervous system depression, gastrointestinal irritation, liver and kidney damage, cardiac arrhythmia, ventricular tachycardia, and bradycardia. Death from

chloroform overdosing can occur and is attributed to ventricular fibrillation. Chloroform anesthesia can produce delayed death as a result of liver necrosis.

Exposure to chloroform by inhalation, intragastric administration, or intraperitoneal injection produces liver and kidney damage in laboratory animals. The oral LD₅₀ and inhalation LC₅₀ values for the rat are 908 mg/kg and 39,000 mg/m³ per 4 hours, respectively (ACGIH 1980).

Toxicity to Wildlife and Domestic Animals

Limited information is available concerning the toxicity of chloroform to organisms exposed at known concentrations (USEPA 1980). Median effect concentrations for two freshwater and one invertebrate species range from 28,900 to 115,000 µg/liter. Twenty-seven day LC₅₀ values of 2,030 and 1,240 µg/liter were reported for embryo-larval tests with rainbow trout in water at two levels of hardness. The only reliable result concerning the toxicity of chloroform to saltwater aquatic life is a 96-hour LC₅₀ value of 81,500 µg/liter for pink shrimp.

An equilibrium bioconcentration factor of six with a tissue half-life of less than 1 day was determined for the bluegill. Although chloroform is not strongly bioaccumulated, it is thought to be widely distributed in the environment and can be detected in fish, water birds, marine mammals, and various crops.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria.

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of chloroform in water are:

<u>Risk</u>	<u>Concentration</u>
10 ⁻⁵	1.90 µg/liter
10 ⁻⁶	0.19 µg/liter
10 ⁻⁷	0.019 µg/liter

CAG Unit Risk (USEPA): $8.1 \times 10^{-2} (\text{mg/kg/day})^{-1}$

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Primary Drinking Water Standard: 0.10 mg/liter (total trihalomethanes)

NIOSH Recommended Standard: 9.8 mg/m³ 1-hr Ceiling Level

OSHA Standard: 244 mg/m³ Ceiling Level

ACGIH Threshold Limit Value: 50 mg/m³ (suspected human carcinogen)

REFERENCES

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1,1-DICHLOROETHANE

Summary

1,1-Dichloroethane is quite volatile and probably is not very persistent in aquatic environments. Inhalation exposure to high doses causes central nervous system depression in humans and may cause hepatotoxicity. In animals, high doses cause liver and kidney damage and retard fetal development.

CAS Number: 75-34-3

Chemical Formula: CH_3CHCl_2

IUPAC Name: 1,1-Dichloroethane

Important Synonyms and Trade Names: Ethylidene chloride, ethylidene dichloride

Chemical and Physical Properties

Molecular Weight: 98.96

Boiling Point: 57.3°C

Melting Point: -97.0°C

Specific Gravity: 1.1776 at 20°C

Solubility in Water: 5 g/liter

Solubility in Organics: Miscible in alcohol

Log Octanol/Water Partition Coefficient: 1.79

Vapor Pressure: 180 mm Hg at 20°C

Transport and Fate

1,1-Dichloroethane disperses from surface water primarily by volatilization into the troposphere, where it is subsequently broken down by hydroxylation. No studies on adsorption were found in the literature reviewed, but because of its water solubility and relatively low log octanol/water partition coefficient, 1,1-dichloroethane potentially could move through soil and enter the groundwater.

1,1-Dichloroethane

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Health Effects

Limited toxicological testing of 1,1-dichloroethane has been conducted, although the literature indicates that 1,1-dichloroethane is one of the least toxic of the chlorinated ethanes. An NCI bioassay on 1,1-dichloroethane was limited by poor survival of test animals of test animals, but some marginal tumorigenic effects were seen. Inhalation exposure to high doses of 1,1-dichloroethane (over 16,000 mg/m³) caused retarded fetal development in rats (Schwetz et al. 1974). 1,1-Dichloroethane was not found to be mutagenic using the Ames assay. 1,1-Dichloroethane causes central nervous system depression when inhaled at high concentrations, and evidence suggests that the compound is hepatotoxic in humans. Kidney and liver damage was seen in animals exposed to high levels of 1,1-dichloroethane. The oral LD₅₀ value in the rat is 725 mg/kg.

Toxicity to Wildlife and Domestic Animals

No information on the toxicity of 1,1-dichloroethane to aquatic species was reported in the literature reviewed. However, the available information on the chloroethanes indicates that toxicity declines with decreases in chlorination and that the 1,1,1-isomer is less active than the 1,1,2-isomer. Therefore 1,1-dichloroethane is probably no more toxic than 1,2-dichloroethane, which is acutely toxic at levels of 100-500 mg/liter and has a chronic toxicity beginning at about 20 mg/liter.

No information on the toxicity of 1,1-dichloroethane to terrestrial wildlife or domestic animals was found in the sources reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

The available data were inadequate for establishing criteria.

OSHA Standard (air): 400 mg/m³ TWA

ACGIH Threshold Limit Value: 810 mg/m³ TWA

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Summary

1,2-Dichloroethane (ethylene dichloride) is a volatile organic solvent, and volatilization and percolation into ground-water may be significant routes of transport. It has a low solubility in water and may be a component in nonaqueous-phase liquids. 1,2-Dichloroethane is carcinogenic in animals and mutagenic in bacterial test systems; it is a suspected human carcinogen.

CAS Number: 107-06-2

Chemical Formula: $\text{CH}_2\text{ClCH}_2\text{Cl}$

IUPAC Name: 1,2-Dichloroethane

Important Synonyms and Trade Names: Ethylene dichloride, glycol dichloride

Chemical and Physical Properties

Molecular Weight: 98.96

Boiling Point: 83-84°C

Melting Point: -35.4°C

Specific Gravity: 1.253 at 20°C

Solubility in Water: 8 g/liter

Solubility in Organics: Miscible with alcohol, chloroform, and ether

Log Octanol/Water Partition Coefficient: 1.48

Vapor Pressure: 61 mm Hg at 20°C

Flash Point: 15°C (closed cup)

1,2-Dichloroethane

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Transport and Fate

The primary method of dispersion from surface water for 1,2-dichloroethane is volatilization. In the atmosphere, 1,2-dichloroethane is rapidly broken down by hydroxylation, although some may be absorbed by atmospheric water and return to the earth by precipitation. No studies on the adsorption of 1,2-dichloroethane onto soil were reported in the literature examined. However, 1,2-dichloroethane has a low octanol/water partition coefficient, is slightly soluble in water, and therefore leaching through the soil into the groundwater is an expected route of dispersal.

Health Effects

1,2-Dichloroethane is carcinogenic in rats and mice, producing a variety of tumors. When administered by gavage, it produced carcinomas of the forestomach and hemangiosarcomas of the circulatory system in male rats; adenocarcinomas of the mammary gland in female rats; lung adenomas in male mice; and lung adenomas, mammary adenocarcinomas, and endometrial tumors in female mice. It is mutagenic when tested using bacterial test systems. Human exposure by inhalation to 1,2-dichloroethane has been shown to cause headache, dizziness, nausea, vomiting, abdominal pain, irritation of the mucous membranes, and liver and kidney dysfunction. Dermatitis may be produced by skin contact. In severe cases, leukocytosis (an excess of white blood cells) may be diagnosed; and internal hemorrhaging and pulmonary edema leading to death may occur. Similar effects are produced in experimental animals.

Toxicity to Wildlife and Domestic Animals

1,2-Dichloroethane is one of the chlorinated ethanes least toxic to aquatic life. For both fresh- and saltwater species, it is acutely toxic at concentrations greater than 118 mg/liter, while chronic toxicity has been observed at 20 mg/liter. 1,2-Dichloroethane is not likely to bioconcentrate, as its steady state bioconcentration factor was 2 and its elimination half-life was less than 2 days in bluegill.

No information on the toxicity of 1,2-dichloroethane to domestic animals or terrestrial wildlife was available in the literature reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria. However, EPA did report the lowest values known to be toxic in aquatic organisms.

Freshwater

Acute toxicity: 118 mg/liter
Chronic toxicity: 20 mg/liter

Saltwater

Acute toxicity: 113 mg/liter
Chronic toxicity: No available data

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of 1,2-dichloroethane in water are:

<u>Risk</u>	<u>Concentration</u>
10^{-5}	9.4 µg/liter
10^{-6}	0.94 µg/liter
10^{-7}	0.094 µg/liter

CAG Unit Risk (USEPA): 9.1×10^{-2} (mg/kg/day)⁻¹

OSHA Standards: 200 mg/m³ TWA
400 mg/m³ Ceiling Level
800 mg/m³ for 5 min every 3 hr, Peak Concentration

ACGIH Threshold Limit Values: 40 mg/m³ TWA
60 mg/m³ STEL

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1,2-Dichloroethane
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1,1-DICHLOROETHYLENE

Summary

1,1-Dichloroethylene (VDC, vinylidene chloride) caused kidney tumors (in males only) and leukemia in one study of mice exposed by inhalation, but the results of other studies were equivocal or negative. 1,1-Dichloroethylene is mutagenic, and it caused adverse reproductive effects when administered to rats and rabbits by inhalation. Chronic exposure causes liver damage, and acute exposure to high doses produces nervous system damage.

CAS Number: 75-35-4

Chemical Formula: CH_2CCl_2

IUPAC Name: 1,1-Dichloroethene

Important Synonyms and Trade Names: Vinylidene chloride, VDC,
1,1-dichloroethene, 1,1-DCE

Chemical and Physical Properties

Atomic Weight: 96.94

Boiling Point: 37°C

Melting Point: -122.1°C

Specific Gravity: 1.218 at 20°C

Solubility in Water: 400 mg/liter at 20°C

Solubility in Organics: Sparingly soluble in alcohol, ether,
acetone, benzene, and chloroform

Log Octanol/Water Partition Coefficient: 1.48

Vapor Pressure: 500 mm Hg at 20°C

Vapor Density: 3.25

Transport and Fate

Volatilization appears to be the primary transport process for 1,1-dichloroethylene (VDC), and its subsequent photooxida-

1,1-Dichloroethylene

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tion in the atmosphere by reaction with hydroxyl radicals is apparently the predominant fate process. Information on other transport and fate mechanisms was generally lacking for 1,1-dichloroethylene. However, by inference from related compounds, hydrolysis, sorption, bioaccumulation, biotransformation, and biodegradation probably all occur but at rates too slow to be of much significance.

Health Effects

1,1-Dichloroethylene caused kidney tumors in males and leukemia in males and females in one study of mice exposed by inhalation, gave equivocal results in other inhalation studies, and gave negative results in rats and mice following oral exposure and in hamsters following inhalation exposure. VDC was mutagenic in several bacterial assays. 1,1-Dichloroethylene did not appear to be teratogenic but did cause embryotoxicity and fetotoxicity when administered to rats and rabbits by inhalation. Chronic exposure to oral doses of VDC as low as 5 mg/kg/day caused liver changes in rats. Acute exposure to high doses causes central nervous system depression, but neurotoxicity has not been associated with low-level chronic exposure. The oral LD₅₀ value for the rat is 1,500 mg/kg, and for the mouse it is 200 mg/kg.

Toxicity to Wildlife and Domestic Animals

1,1-Dichloroethylene is not very toxic to freshwater or saltwater species, with acute LC₅₀ values generally ranging from 80 to 200 mg/liter. A chronic study in which no adverse effects were observed indicated that the acute-chronic ratio was less than 40; a 13-day study that produced an LC₅₀ of 29 mg/liter indicated that the acute-chronic ratio is greater than 4.

No reports of the toxicity of 1,1-dichloroethylene to terrestrial wildlife or domestic animals were found in the literature reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are inadequate for establishing criteria. However, EPA did report the lowest values known to cause toxicity in aquatic organisms.

Freshwater

Acute toxicity: 11,600 µg/liter
Chronic toxicity: No available data

Saltwater

Acute toxicity: 224,000 µg/liter
Chronic toxicity: No available data

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of 1,1-dichloroethylene in water are:

<u>Risk</u>	<u>Concentration</u>
10 ⁻⁵	0.33 µg/liter
10 ⁻⁶	0.033 µg/liter
10 ⁻⁷	0.0033 µg/liter

CAG Unit Risk (USEPA): 1.16 (mg/kg/day)⁻¹

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1,2-trans-DICHLOROETHYLENE

Summary

Chronic inhalation exposure to 1,2-trans-dichloroethylene (1,2-trans-DCE) causes liver degeneration, and acute exposure to high levels has adverse effects on the central nervous system.

CAS Number: 540-59-0

Chemical Formula: $C_2H_2Cl_2$

IUPAC Name: 1,2-trans-Dichloroethene

Important Synonyms and Trade Names: trans-Acetylene dichloride,
dioform

Chemical and Physical Properties

Molecular Weight: 96.94

Boiling Point: 47.5°C

Melting Point: -50°C

Specific Gravity: 1.2565 at 20°C

Solubility in Water: 600 mg/liter

Solubility in Organics: Miscible with alcohol, ether, and acetone;
very soluble in benzene and chloroform

Log Octanol/Water Partition Coefficient: 1.48 (calculated)

Vapor Pressure: 200 mm Hg at 14°C

Flash Point: 3°C (undefined isomers)

Transport and Fate

Due to the relatively high vapor pressure of 1,2-trans-dichloroethylene (1,2-trans-DCE), volatilization from aquatic systems to the atmosphere is quite rapid and appears to be the primary transport process. Aerial transport of this compound can occur and is partly responsible for its relatively wide

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environmental distribution. Although little applicable information is available, adsorption is probably an insignificant environmental fate process for 1,2-trans-DCE. The relatively low log octanol/water partition coefficient of 1,2-trans-DCE suggests that bioaccumulation also is a relatively insignificant process. Although no information pertaining specifically to biodegradation of 1,2-trans-DCE is available, results with similar compounds suggest that this process probably occurs but at a very slow rate.

Photooxidation in the troposphere appears to be the dominant environmental fate of 1,2-trans-DCE. Once in the troposphere, the compound is attacked at the double bond by hydroxyl radicals, resulting in the formation of formic acid, hydrochloric acid, carbon monoxide, and formaldehyde. The half-life of 1,2-trans-DCE in the troposphere is estimated to be less than one day. Given the properties of similar compounds, photolysis of 1,2-trans-DCE in aquatic systems and photodissociation in the terrestrial environment are probably insignificant.

Health Effects

Very little information concerning exposure only to 1,2-trans-DCE is available. There are no reports of carcinogenic or teratogenic activity by 1,2-trans-DCE in animals or humans. It is reportedly nonmutagenic in a variety of test systems. Like other members of the chlorinated ethylene series, 1,2-trans-DCE has anesthetic properties. Exposure to high vapor concentrations has been found to cause nausea, vomiting, weakness, tremor, and cramps in humans. Repeated exposure via inhalation of 800 mg/m³ (8 hours/day, 5 days/week, for 16 weeks) was reported to produce fatty degeneration of the liver in rats. The intraperitoneal injection LD₅₀ value for the rat is 7,536 mg/kg.

Although nephrotoxic and cardiac sensitizing effects are associated with exposure to 1,1-dichloroethylene, the 1,2-DCE isomers have not been investigated with respect to this type of effects. 1,2-trans-Dichloroethylene can inhibit aminopyrine demethylation in rat liver microsomes in vitro, and it may thus interact with the hepatic drug-metabolizing monooxygenase system.

Toxicity to Wildlife and Domestic Animals

Practically no information concerning the toxicity of 1,2-trans-DCE to wildlife and domestic animals exists. The reported 96-hour LC₅₀ value under static conditions is 135,000 µg/liter for the bluegill. Under the same test conditions, the LC₅₀ value for 1,1-dichloroethylene is 73,900 µg/liter. Recommended criteria for protection of aquatic life are based primarily on data concerning 1,1-dichloroethylene.

1,2-trans-Dichloroethylene

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Regulations and Standards

Ambient Water Quality Criteria (USEPA):

The available data are not adequate for establishing criteria.

OSHA Standard: 790 mg/m³ TWA

ACGIH Threshold Limit Values: 790 mg/m³ TWA
1,000 mg/m³ STEL

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TETRACHLOROETHYLENE

Summary

Tetrachloroethylene (PCE, perchloroethylene) induced liver tumors when administered orally to mice and was found to be mutagenic using a microbial assay system. Reproduction toxicity was observed in pregnant rats and mice exposed to high concentrations. Animals exposed by inhalation to tetrachloroethylene exhibited liver, kidney, and central nervous system damage.

CAS Number: 127-18-4

Chemical Formula: C_2Cl_4

IUPAC Name: Tetrachloroethene

Important Synonyms and Trade Names: Perchloroethylene, PCE

Chemical and Physical Properties

Molecular Weight: 165.83

Boiling Point: 121°C

Melting Point: -22.7°C

Specific Gravity: 1.63

Solubility in Water: 150 to 200 mg/liter at 20°C

Solubility in Organics: Soluble in alcohol, ether, and benzene

Log Octanol/Water Partition Coefficient: 2.88

Vapor Pressure: 14 mm Hg at 20°C

Transport and Fate

Tetrachloroethylene (PCE) rapidly volatilizes into the atmosphere where it reacts with hydroxyl radicals to produce HCl, CO, CO₂, and carboxylic acid. This is probably the most important transport and fate process for tetrachloroethylene in the environment. PCE will leach into the groundwater, especially in soils of low organic content. In soils with high levels of organics, PCE adsorbs to these materials and can

be bioaccumulated to some degree. However, it is unclear if tetrachloroethylene bound to organic material can be degraded by microorganisms or must be desorbed to be destroyed. There is some evidence that higher organisms can metabolize PCE.

Health Effects

Tetrachloroethylene was found to produce liver cancer in male and female mice when administered orally by gavage (NCI 1977). Unpublished gavage studies in rats and mice performed by the National Toxicology Program (NTP) showed hepatocellular carcinomas in mice and a slight, statistically insignificant increase in a rare type of kidney tumor.¹ NTP is also conducting an inhalation carcinogenicity study. Elevated mutagenic activity was found in *Salmonella* strains treated with tetrachloroethylene. Delayed ossification of skull bones and sternebrae were reported in offspring of pregnant mice exposed to 2,000 mg/m³ of tetrachloroethylene for 7 hours/day on days 6-15 of gestation. Increased fetal resorptions were observed after exposure of pregnant rats to tetrachloroethylene. Renal toxicity and hepatotoxicity have been noted following chronic inhalation exposure of rats to tetrachloroethylene levels of 1,356 mg/m³. During the first 2 weeks of a subchronic inhalation study, exposure to concentrations of 1,622 ppm (10,867 mg/m³) of tetrachloroethylene produced signs of central nervous system depression, and cholinergic stimulation was observed among rabbits, monkeys, rats, and guinea pigs.

Toxicity to Wildlife and Domestic Animals

Tetrachloroethylene is the most toxic of the chloroethylenes to aquatic organisms but is only moderately toxic relative to other types of compounds. The limited acute toxicity data indicate that the LC₅₀ value for saltwater and freshwater species are similar, around 10,000 µg/liter; the trout was the most sensitive (LC₅₀ = 4,800 µg/liter). Chronic values were 840 and 450 µg/liter for freshwater and saltwater species, respectively, and an acute-chronic ratio of 19 was calculated.

No information on the toxicity of tetrachloroethylene to terrestrial wildlife or domestic animals was available in the literature reviewed.

¹J. Mennear, NTP Chemical Manager; personal communication, 1984.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria. However, EPA did report the lowest values known to be toxic to aquatic organisms.

Freshwater

Acute toxicity: 5,280 µg/liter
Chronic toxicity: 840 µg/liter

Saltwater

Acute toxicity: 10,200 µg/liter
Chronic toxicity: 450 µg/liter

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of tetrachloroethylene in water are:

<u>Risk</u>	<u>Concentration</u>
10^{-5}	8.0 µg/liter
10^{-6}	0.8 µg/liter
10^{-7}	0.08 µg/liter

CAG Unit Risk (USEPA): 5.1×10^{-2} (mg/kg/day)⁻¹

NIOSH Recommended Standards (air): 335 mg/m³ TWA
670 mg/m³ 15-min Ceiling Level

OSHA Standards (air): 670 mg/m³ TWA
1,340 mg/m³ Ceiling Level
2,010 mg/m³ for 5 min every 3 hr, Peak Level

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TRICHLOROBENZENE

Summary

High doses of trichlorobenzene (TCB) have been shown to be embryotoxic to the offspring of exposed rats. Dermal applications of TCB increased the incidence of amyloidosis in a number of organs in mice and consequently shortened the animals' life-spans. Inhalation exposure to trichlorobenzene had minor effects on the liver and kidneys in several species of experimental animals; in a study in mice, it also damaged the bone marrow.

CAS Number: 1,2,3-TCB: 87-61-6
1,2,4-TCB: 120-82-1
1,3,5-TCB: 108-70-3

Chemical Formula: $C_6H_3Cl_3$

IUPAC Names: 1,2,3-Trichlorobenzene; 1,2,4-Trichlorobenzene;
1,3,5-Trichlorobenzene

Important Synonyms and Trade Names: Trichlorobenzene, TCB

Chemical and Physical Properties

Molecular Weight: 181.45

Boiling Point: 1,2,3-TCB: 219°C
1,2,4-TCB: 213°C
1,3,5-TCB: 208°C

Melting Point: 1,2,3-TCB: 54°C
1,2,4-TCB: 17°C
1,3,5-TCB: 64°C

Specific Gravity: 1,2,4-TCB: 1.4542

Solubility in Water: 1,2,4-TCB: 30 mg/liter at 25°C

Solubility in Organics: Sparingly soluble in alcohol; freely
soluble in benzene and carbon disulfide

Log Octanol/Water Partition Coefficient: 1,2,3-TCB: 4.1
1,2,4-TCB: 4.3 (calculate)

Vapor Pressure: Approximately 0.4 mm Hg at 25°C

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Transport and Fate

There is little information on the transport and fate of trichlorobenzenes, and what is available primarily concerns 1,2,4-trichlorobenzene (1,2,4-TCB). Although there is no information on the sorption of 1,2,4-TCB to soils and sediments, the high log octanol/water partition coefficient suggests that this compound would be adsorbed to organic materials in soil and sediment. The volatility of 1,2,4-TCB is relatively low, but it has been found to volatilize readily from aerated and quiescent waters, with a half-life of less than 1 hour and 4-7 hours in each medium, respectively. Thus, air transport is also likely. Sorption to suspended solids does, however, reduce the rate of volatilization.

1,2,4-TCB has been shown to be oxidized in the atmosphere via attack by hydroxyl radicals. It is not known if the compound is broken down through photolysis or hydrolysis. Biodegradation of 1,2,4-TCB has been shown to occur in waste treatment studies. However, in the environment biodegradation is expected to be slower.

Health Effects

There are no reports indicating carcinogenic, teratogenic, or mutagenic activity of the trichlorobenzenes in humans or animals. No specific reproductive effects have been found for the TCBs, but embryotoxicity has been noted at a dose level that produces maternal toxicity in rats (Kitchin and Ebron 1983).

Several animal studies on the subchronic toxicity of trichlorobenzenes have been reported. Inhalation studies with 1,2,4-TCB of 1.5 to 6 months duration in rats, rabbits, dogs, and monkeys have not shown major irreversible effects, although some effects on liver and kidney were found (transient histological changes and increased relative liver weight; Kociba et al. 1981, Coate et al. 1982). Increased urinary porphyrin levels were also noted (Kociba et al. 1981). Zub (1978) reported that mice exposed to TCB (isomers unspecified) for 3 weeks to 3 months showed indications of bone marrow damage. In a chronic study in which mice were administered 1,2,4-TCB by dermal application, there was a treatment-related increase in the incidence of amyloidosis, which affected a number of organs and was considered a primary cause of death (Yamamoto et al. 1982).

TCB is an inducer of the microsomal mixed function oxidases and therefore will increase metabolism, leading to the inactivation or activation of chemicals affected by this system.

Toxicity to Wildlife and Domestic Animals

Only 1,2,4-TCB has been studied for its toxic effect on aquatic wildlife. Acute LC₅₀ values for the freshwater species *Daphnia magna*, rainbow trout, and fathead minnow are 50.2, 1.5, and 2.87 mg/liter, respectively. In the saltwater species, the LC₅₀ values are 0.45 and 21.4 mg/liter for mysid shrimp and sheepshead minnow, respectively. Chronic toxicity in the early life stage of the fathead minnow occurred at concentrations of 1,2,4-TCB that ranged from 0.206 to 0.705 mg/liter. In freshwater and saltwater algae, the EC₅₀ values for 1,2,4-TCB on chlorophyll are 35.3 and 8.75, respectively; and for its effect on cell numbers, the EC₅₀ values are 36.7 and 8.93 mg/liter, respectively.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

The available data are not adequate for establishing criteria.

ACGIH Threshold Limit Value: 1,2,4-TCB: 40 mg/m³ TWA

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TRICHLOROETHYLENE

Summary

Trichloroethylene (TCE) induced hepatocellular carcinomas in mice and was mutagenic when tested using several microbial assay systems. Chronic inhalation exposure to high concentrations caused liver, kidney, and neural damage and dermatological reactions in animals.

CAS Number: 79-01-6

Chemical Formula: C_2HCl_3

IUPAC Name: Trichloroethene

Important Synonyms and Trade Names: Trichloroethene, TCE,
and ethylene trichloride

Chemical and Physical Properties

Molecular Weight: 131.5

Boiling Point: 87°C

Melting Point: -73°C

Specific Gravity: 1.4642 at 20°C

Solubility in Water: 1,000 mg/liter

Solubility in Organics: Soluble in alcohol, ether, acetone,
and chloroform

Log Octanol/Water Partition Coefficient: 2.29

Vapor Pressure: 60 mm Hg at 20°C

Vapor Density: 4.53

Transport and Fate

Trichloroethylene (TCE) rapidly volatilizes into the atmosphere where it reacts with hydroxyl radicals to produce hydrochloric acid, carbon monoxide, carbon dioxide, and carboxylic acid. This is probably the most important transport and fate process for trichloroethylene in surface water and in the upper

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layer of soil. TCE adsorbs to organic materials and can be bioaccumulated to some degree. However, it is unclear whether trichloroethylene bound to organic material can be degraded by microorganisms or must be desorbed to be destroyed. There is some evidence that higher organisms can metabolize TCE. Trichloroethylene leaches into the groundwater fairly readily, and it is a common contaminant of groundwater around hazardous waste sites.

Health Effects

Trichloroethylene is carcinogenic to mice after oral administration, producing hepatocellular carcinomas (NCI 1976, NTP 1982). It was found to be mutagenic using several microbial assay systems. Trichloroethylene does not appear to cause reproductive toxicity or teratogenicity. TCE has been shown to cause renal toxicity, hepatotoxicity, neurotoxicity, and dermatological reactions in animals following chronic exposure to levels greater than 2,000 mg/m³ for 6 months. Trichloroethylene has low acute toxicity; the acute oral LD₅₀ value in several species ranged from 6,000 to 7,000 mg/kg.

Toxicity to Wildlife and Domestic Animals

There was only limited data on the toxicity of trichloroethylene to aquatic organisms. The acute toxicity to freshwater species was similar in the three species tested, with LC₅₀ values of about 50 mg/liter. No LC₅₀ values were available for saltwater species. However, a dose of 2 mg/liter caused erratic swimming and loss of equilibrium in the grass shrimp. No chronic toxicity tests were reported.

No information on the toxicity of trichloroethylene to domestic animals or terrestrial wildlife was available in the literature reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Toxicity

The available data are not adequate for establishing criteria. However, EPA did report the lowest values known to be toxic in aquatic organisms.

Freshwater

Acute toxicity: 45 mg/liter
Chronic toxicity: No available data

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Saltwater

Acute toxicity: 2 mg/liter

Chronic toxicity: No available data

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of trichloroethylene in water are:

<u>Risk</u>	<u>Concentration</u>
10^{-5}	27 µg/liter
10^{-6}	2.7 µg/liter
10^{-7}	0.27 µg/liter

CAG Unit Risk (USEPA): 1.1×10^{-2} (mg/kg/day)⁻¹

NIOSH Recommended Standards (air): 540 mg/m³ TWA
760 mg/m³ 10-min Ceiling Level

OSHA Standards (air): 540 mg/m³ TWA
1,075 mg/m³ 15-min Ceiling Level
1,620 mg/m³ for 5 min every 3 hr,
Peak Concentration

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1,1,2-TRICHLOROETHANE

Summary

1,1,2-Trichloroethane induced liver tumors and pheochromocytomas in mice. It caused liver and kidney damage in dogs.

CAS Number: 79-00-5

Chemical Formula: $\text{CH}_2\text{ClCHCl}_2$

IUPAC Name: 1,1,2-Trichloroethane

Important Synonyms and Trade Names: Vinyl trichloride, ethane trichloride

Chemical and Physical Properties

Molecular Weight: 133.41

Boiling Point: 133.8°C

Melting Point: -36.5°C

Specific Gravity: 1.4397 at 20°C

Solubility in Water: 4,500 mg/liter at 20°C

Solubility in Organics: Soluble in alcohol, ether, and chloroform

Log Octanol/Water Partition Coefficient: 2.17

Vapor Pressure: 19 mm Hg at 20°C

Vapor Density: 4.63

Transport and Fate

Volatilization and subsequent photooxidation in the troposphere are probably the primary transport and fate processes for 1,1,2-trichloroethane. Some sorption, bioaccumulation, and biodegradation may occur, but these processes are probably not very important processes for trichloroethane transport or fate.

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1,1,2-Trichloroethane induced hepatocellular carcinomas and pheochromocytoma of the adrenal gland in male and female mice but did not produce a significant increase in tumor incidence in male or female rats (NCI 1977). It was not mutagenic when tested using the Ames assay. No information was found concerning the reproductive toxicity or teratogenicity of 1,1,2-trichloroethane. No chronic studies were found on the toxicity of 1,1,2-trichloroethane but single doses as low as 400 mg/kg caused liver and kidney damage in dogs. The oral LD₅₀ value for 1,1,2-trichloroethane in rats is 835 mg/kg.

Toxicity to Wildlife and Domestic Animals

The acute LC₅₀ values for 1,1,2-trichloroethane for freshwater aquatic organisms ranged from 18,000 to 81,700 µg/liter. One chronic test was conducted; this indicated that the acute-chronic ratio for 1,1,2-trichloroethane was around 8.7. No information on the toxicity of 1,1,2-trichloroethane to saltwater species, terrestrial wildlife, or domestic animals was available in the literature reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not sufficient for establishing criteria. However, EPA did report the lowest values known to be toxic in aquatic organisms.

Freshwater

Acute toxicity: 18,000 µg/liter
Chronic toxicity: 9,400 µg/liter

Saltwater

Acute toxicity: No available data
Chronic toxicity: No available data

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of 1,1,2-trichloroethane in water are:

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<u>Risk</u>	<u>Concentration</u>
10 ⁻⁵	6.0 µg/liter
10 ⁻⁶	0.6 µg/liter
10 ⁻⁷	0.06 µg/liter

CAG Unit Risk (USEPA): 5.7×10^{-2} (mg/kg/day)⁻¹

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 Clement Associates

VINYL CHLORIDE

I. CHEMICAL AND PHYSICAL INFORMATION

- A. Chemical Name: Chloroethylene
- B. Synonyms: Vinyl chloride
MVC
- C. Trade Names: No information was found.
- D. CAS No.: 75-01-4
- E. Molecular Formula: C_2H_3Cl
- F. Structural Formula: $CH_2 = CHCl$
- G. Molecular Weight: 62.5
- H. Physical Properties:
1. Physical State: Gas (Verschuereen, 1983).
 2. Color: Colorless (Verschuereen, 1983).
 3. Odor/Odor Threshold: Odor: mild, sweetish, faintly pleasant at high concentrations (Verschuereen, 1983).
 4. Melting Point: $-153.8^{\circ}C$ (Windholz, 1983).
 5. Boiling Point: $-13.37^{\circ}C$ (Windholz, 1983).
 6. Flash Point: No information was found.
 7. Autoignition Temperature: $882^{\circ}F$ ($472^{\circ}C$) (closed cup) (Baker, 1978).
 8. Flammable Limits: 3.6-33.0% (Baker, 1978).
 9. Vapor Pressure: 240 mm @ $-40^{\circ}C$, 580 mm @ $-20^{\circ}C$, 2,660 mm @ $25^{\circ}C$ (Verschuereen, 1983).
 10. Specific Gravity: 0.9106 @ $20^{\circ}C$ referred to water at $4^{\circ}C$ (Windholz, 1983).
 11. Vapor Density: 2.15 (air = 1) (Verschuereen, 1983).
 12. Refractive Index: $n_D^{20} = 1.3700$ (Windholz, 1983).
 13. Solubility in Water: 1.1 mg/L @ $25^{\circ}C$ (Verschuereen, 1983).

14. Solubility in Organic Solvents: Soluble in alcohol, ether, carbon tetrachloride, benzene (Windholz, 1983).
15. Log Partition Coefficients: 0.6 (octanol/water) (Callahan et al., 1979).
16. Henry's Law Constant: $2.4 \text{ atm m}^3/\text{mol}$ (Thomas, 1982).
17. Other: Polymerizes in light or in presence of a catalyst (Windholz, 1983).

II. ENVIRONMENTAL FATE

- A. Air: Vinyl chloride reacts in the troposphere with photochemically produced hydroxyl radicals with a half-life of 1.2 days. The products of reaction include chloroacetaldehyde, hydrochloric acid, chloroethylene epoxide, formaldehyde, formyl chloride, formic acid, and carbon monoxide (Muller et al., 1977; Kagiya et al., 1975). In the presence of nitrogen oxides, the half-life is reduced to 3-7 hours (Carassiti et al., 1978; Woldbaek, 1978; Gay et al, 1976).
- B. Soil: No experimental data were found on the adsorption of vinyl chloride to soil. Because of its high vapor pressure (Verschueren, 1983) and low octanol/water partition coefficient (Callahan et al., 1979), vinyl chloride would not be expected to show appreciable adsorption to soil; vinyl chloride released to land would be expected to disappear rapidly, primarily through volatilization.
- C. Water: Vinyl chloride released into water is primarily lost through evaporation into the atmosphere (Charlton, 1983). The half-life for this process may range from hours to days and has been calculated to be 2.5 hours (Lyman, 1982). In water, no photodegradation was observed in 90 hours (Callahan et al., 1979).

No biodegradation of vinyl chloride in an aerobic system was observed over a period of 50 days (Helfgott, 1979, as cited in CHEMFATE, 1987).
- D. Bioconcentration: Vinyl chloride's log octanol/water partition coefficient of 0.6 indicates that it will have little tendency to concentrate in the food chain (Callahan et al., 1979; Lu et al., 1977, as cited in CHEMFATE, 1987).

III. EXPOSURE AND BIOLOGICAL DISPOSITION

- A. Exposure: Vinyl chloride is absorbed via inhalation and ingestion (Sax, 1975; Gosselin et al., 1984).

- B. Bioavailability: No information was found concerning the bioavailability of vinyl chloride in humans. Rats receiving oral doses of vinyl chloride as high as 100 mg/kg-bw absorbed approximately 85%. Rats exposed to initial atmosphere concentrations below 260 mg/m³ absorbed 40% of the dose inspired (IARC, 1982).
- C. Pharmacology: Vinyl chloride is primarily converted to chloroethylene oxide which spontaneously rearranges to chloroacetaldehyde which, in turn, is oxidized to monochloroacetic acid or reduced to chloroethanol. Monochloroacetic acid is seen only with exposures to high concentrations. Chloroethanol is probably excreted via the glutathione-cysteine conjugation system. When the system is overloaded, as in exposure to high concentrations, unchanged vinyl chloride is eliminated by the lungs. In rats, 69% of an absorbed dose was excreted by the kidneys in 24 hours in the form of metabolites, and an additional 1.7% was expected in the next 24 hours. As much as 12% was exhaled at an exposure concentration of 1000 ppm, while this figure was only 2% at an exposure concentration of 10 ppm (EOH&S, 1983; Rumack, 1975-present).

IV. TOXICITY

- A. Acute toxicity: Vinyl chloride may cause CNS and respiratory depression at high concentrations (Rumack, 1975-present). Exposure to a concentration of 2.5% vinyl chloride in air for a period of 3 minutes will cause dizziness and disorientation in humans (Clayton and Clayton, 1981). Acute exposure to unspecified high atmospheric concentrations of vinyl chloride may produce euphoria followed by a state of inebriation similar to that of alcohol intoxication, abdominal pain, nausea and vomiting, anorexia, headache, dizziness, confusion, drowsiness, convulsions, and visual disturbances. Following ingestion, hematemesis and diarrhea might also occur (Gosselin et al., 1984). Two-hour inhalation LC₅₀ values for vinyl chloride are: in mice 294 g/m³ (113,000 ppm); in rats, 390 g/m³ (150,000 ppm); in guinea pigs, 595 g/m³ (230,000 ppm); and in rabbits, 295 g/m³ (113,000 ppm). Vinyl chloride gas has a narcotic effect on experimental animals, the most sensitive species being mice, followed by rats, guinea pigs and rabbits. Death of animals is preceded by excitement, contractions and convulsions, accelerated respiration, followed by respiratory failure. Rabbits and guinea pigs show more accentuated muscular contractions and convulsions than mice and rats. Microscopically, congestion of the internal organs with more intense damage to the lung, liver, and kidneys has been found (Prodan et al., 1975).
- B. Chronic toxicity: Male Wistar rats exposed to a concentration of 30,000 ppm of vinyl chloride, 4 hours/day, 5 days/week for up to 12 months showed degeneration of bone and connective tissue.

Exposure of guinea pigs to 260 g/m³ (100,000 ppm) vinyl chloride for 2 hours/day for 3 months caused marked growth disturbances and intense histopathological and histochemical lesions in the liver, kidneys, spleen and lungs. Interruption of the exposure resulted in a regenerative effect, denoting a certain degree of reversibility of the hepatorenal lesions (Prodan et al., 1975).

In humans, exposure to vinyl chloride is associated with multiple systemic disorders, including a sclerotic syndrome, acro-osteolysis (sometimes associated with Raynaud-like symptomatology), thrombocytopenia and liver damage consisting of parenchymal damage, fibrosis of the liver capsule, periportal fibrosis associated with hepatomegaly, and splenomegaly (Lang et al., 1974; Thomas et al., 1975).

- C. Carcinogenicity: The carcinogenicity of vinyl chloride has been extensively studied in both rats and mice. Groups of 40 male and 40 female Sprague-Dawley rats received gastric intubations of 0, 3.33, 16.65 or 50 mg/kg vinyl chloride dissolved in olive oil 4-5 times/week for 52 weeks. At 120 weeks, 9 liver angiosarcomas, 2 zymbal gland carcinomas and 3 nephroblastomas were found in the 16.65 mg/kg group, and 16 liver angiosarcomas, 2 nephroblastomas, 1 Zymbal gland carcinoma, and 1 thymic and 1 intra-abdominal angiosarcoma in the 50 mg/kg group (Maltoni, 1974; Maltoni, 1977).

Groups of 30 male and 30 female Swiss mice were exposed to concentrations of 130 to 26,000 mg/m³ (50-10,000 ppm) vinyl chloride in air for 4 hours/day, 5 days/week for 30 weeks. At 81 weeks, 176 animals had adenomas and/or adenocarcinomas of the lung, 60 animals had mammary adenocarcinomas and 47 animals had angiosarcomas of the liver. Except for lung tumors, which were not increased in the group treated with 50 ppm, a significantly higher number of neoplasms occurred in all treated groups compared to controls (Maltoni, 1974; Maltoni, 1977).

The International Agency for Research on Cancer states:

"Vinyl chloride is a human carcinogen. Its target organs are the liver, brain, lung and haemo-lymphopoietic system. Similar carcinogenic effects were first demonstrated in rats and were later confirmed in mice and hamsters. Although evidence of a carcinogenic effect of vinyl chloride in humans has come from groups occupationally exposed to high doses of vinyl chloride, there is not evidence that there is an exposure level below which no increased risk of cancer would occur in humans (IARC, 1979)."

- D. Mutagenicity: Vinyl chloride vapor was mutagenic with activation in Salmonella typhimurium strains G46, TA1530, TA1535, and TA100

(Andrews et al., 1976). Vinyl chloride in aqueous or methanolic solution was nonmutagenic in the Salmonella test system (activation and strain of Salmonella not reported) (Bartsch et al., 1975; Rannug et al., 1974) but produced reverse mutations in Escherichia coli K12 (Greim et al., 1975), forward mutations in Schizosaccharomyces pombe and mitotic gene conversions in Saccharomyces cerevisiae. Forward mutations in S. pombe were also induced in the host-mediated assay in mice (Loprieno et al., 1976, 1977).

- D. Developmental and Reproductive Toxicity: Pregnant CF-1 mice were exposed by inhalation to 130 or 1300 mg/m³ (50 or 500 ppm) vinyl chloride on days 6-15 of gestation, for 7 hours/day with or without simultaneous exposure to 15% ethanol in the drinking water. A significantly increased incidence of several skeletal anomalies was observed in offspring of mice that received vinyl chloride plus ethanol (John et al., 1977; Schwetz et al., 1975).

In another study, vinyl chloride was administered via inhalation for 7 hours/day on days 6-18 of gestation in mice, rats, and rabbits. It was concluded that although maternal toxicity was observed, vinyl chloride alone did not cause significant embryonal or fetal toxicity and was not teratogenic in any of the species at the concentration studied (NRC, 1977).

V. ENVIRONMENTAL STANDARDS AND CRITERIA

A. Air:

ACGIH: TWA of 5 ppm (10 mg/m³)

OSHA: OSHA air standard TWA of 1 ppm. Air ceiling 5 ppm/15 min. Meets criteria for proposed OSHA Medical Records Rule.

B. Groundwater:

No information was found.

C. Surface water:

EPA: Ambient Water Quality Criteria (cancer): 20 ppb (aquatic organisms and drinking water); 20 ppb (adjusted for drinking water only)

D. Drinking water:

EPA: Health Advisory (acute): 2600 ppb/10 kg (one-day); 2600 ppb/10 kg (ten-day)
Health Advisory (chronic, non-cancer): 13 ppb/10 kg; 46 ppb/70 kg
Health Advisory (chronic, cancer): 0.015 µg/L

E. Other:

CERCLA: Reportable quantity 1 lb (0.454 kg).

RCRA: Waste Numbers: U043, K020, 40 CFR 261 Appendix VIII
Hazardous Constituent.

TSCA: Section 8(e) status report 8EHQ-0680-0345;
8EHQ-0982-0457; 8EHQ-0378-0104.

FIFRA: Canceled and suspended are all pesticide products
containing this compound, whether an active or inert
ingredient, for uses in the home, food handling
establishments, hospitals or in enclosed areas.

CAG: Group A carcinogen

Risk Characterization for Potential Carcinogenic Effects:

Oral route: Potency factor 2.30 per mg/kg/day

Inhalation route: Potency factor 0.025 per mg/kg/day

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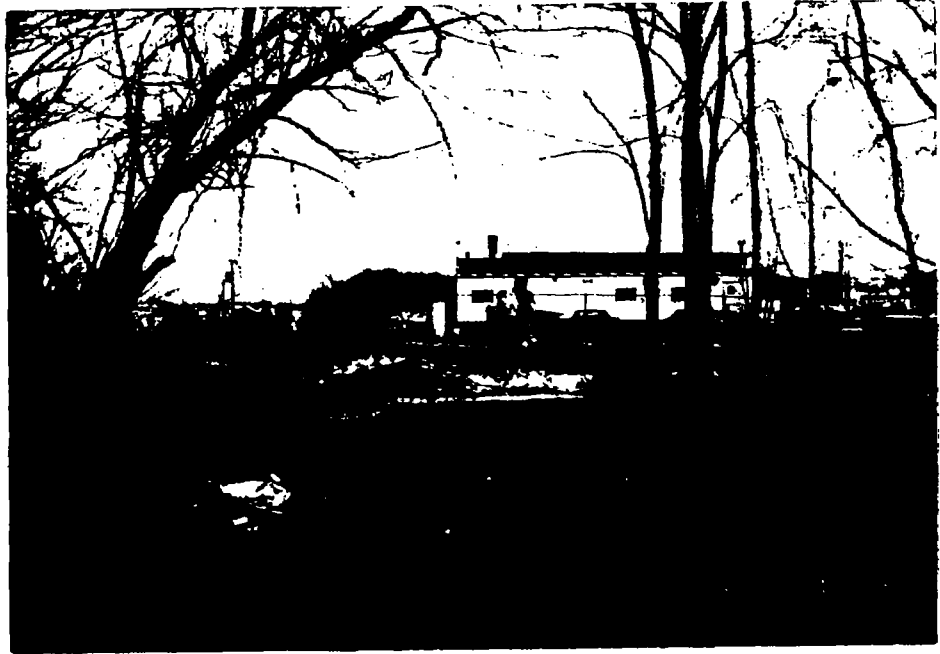
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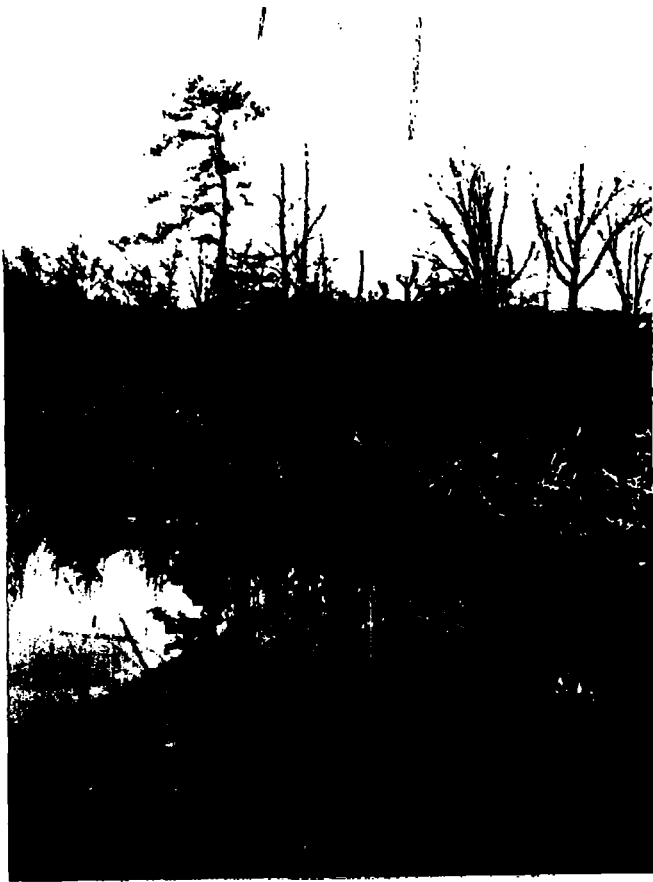
APPENDIX M
PHOTOGRAPHS



Photograph 1 View looking east at the makeshift bridge across the Aberjona River in the foreground, and the 60 Olympia Avenue paved parking lot and building in the background. (March 1990)



Photograph 2 View looking west from the makeshift bridge across the Aberjona at a secondary growth upland forest/open field of white oak, gray birch, red maple, white pine, quaking aspen, sheep laurel, and european buckthorn with an herbaceous layer dominated by upland grasses and goldenrod. (March 1990)



Photograph 3

View looking southwest at the Aberjona River and marsh/shrub swamp. At this point, the river is about 17 feet wide and 2-3 feet deep. The rate of flow was low, about 17 cubic feet per second on March 13, 1990. (March 1990)



Photograph 4

View looking southeast at shallow marsh dominated by sedges, purple loosestrife, and broad-leaved cattails. In the background is a peninsula of oak upland. (March 1990)



Photograph 5 Looking south at the marsh/shrub swamp. Pockets of standing water are interspersed with hummock of purple loosestrife and tussock sedge. (March 1990)



Photograph 6 Similar view to photograph 5 above, but taken in September 1990.



Photograph 7 View looking north from the upland oak peninsula. European buckthorn, gray birch, American hazelnut, choke cherry, grape, wintergreen, and bracken fern are in the forest understory. In the background is the chain-link fence surrounding the 60 Olympia Avenue parking lot and rear view of the main building. (March 1990)



Photograph 8 View looking south from the upland oak peninsula at the marsh/shrub swamp and a small branch of the Aberjona River south of the 60 Olympia Avenue facility. (March 1990)



Photograph 9

View looking northeast at red maple swamp south of the 60 Olympia Avenue facility. Ponded water and buttressed red maple trees suggest wetland hydrology. Dominant wetland plants include: highbush blueberry, sheep laurel, cinnamon fern, and sensitive fern. Siltation fence was installed for construction of an addition to the main building within the 100-foot buffer zone of bordering vegetated wetland.



Photograph 10 View from the parking lot slope looking south at an area within the swamp with abundant tussock sedge and highbush blueberry. Sample location for wetland soil (SS-1).



Photograph 11 September 1990 view of a portion of the swamp pictured above. Spotted jewelweed, an annual, is interspersed with the tussock sedge. A few snags, important nesting habitat for some animals, are found within the swamp.



Photograph 12 View looking south-southeast at the tall reed growth near the parking lot outfall. Wetland soil sample (SS-2) was taken within the reed stand. (March 1990)



Photograph 13

Red maple swamp east of the 60 Olympia Avenue property. Species in the understory include swamp azalea, viburnums, winterberry, swamp dogwood, alder, cinnamon fern, skunk cabbage, and sphagnum moss. (March 1990)



Photograph 14

Red maple swamp near the southeast corner of the 60 Olympia Avenue paved and fenced parking lot. Iron precipitate within a stand of river bulrush at the toe of the parking lot slope. (March 1990)